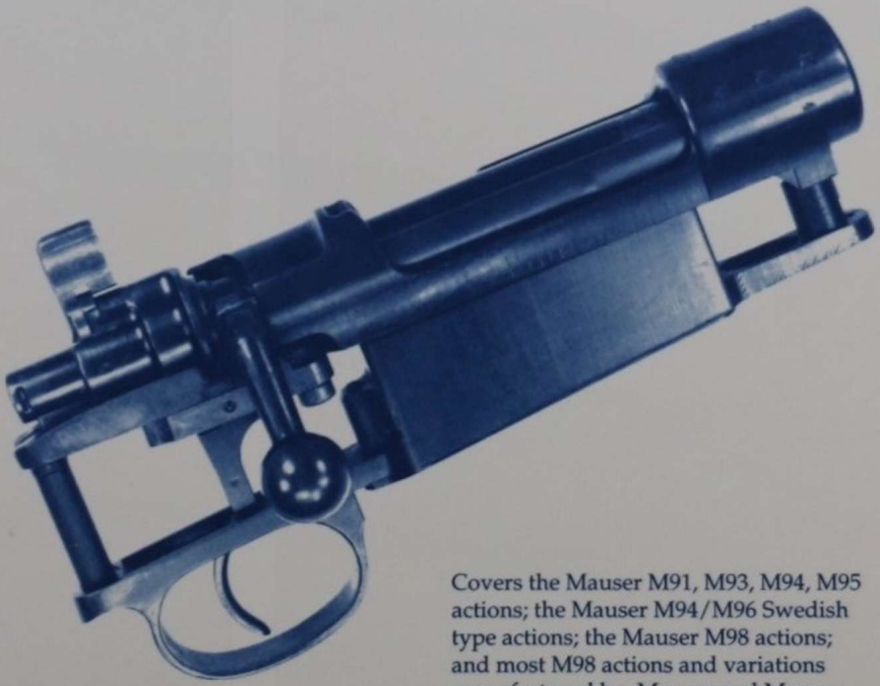
The Mauser
M91 Through M98
Bolt Actions
A Shop Manual



Covers the Mauser M91, M93, M94, M95 actions; the Mauser M94/M96 Swedish type actions; the Mauser M98 actions; and most M98 actions and variations manufactured by Mauser and Mauser European affiliates

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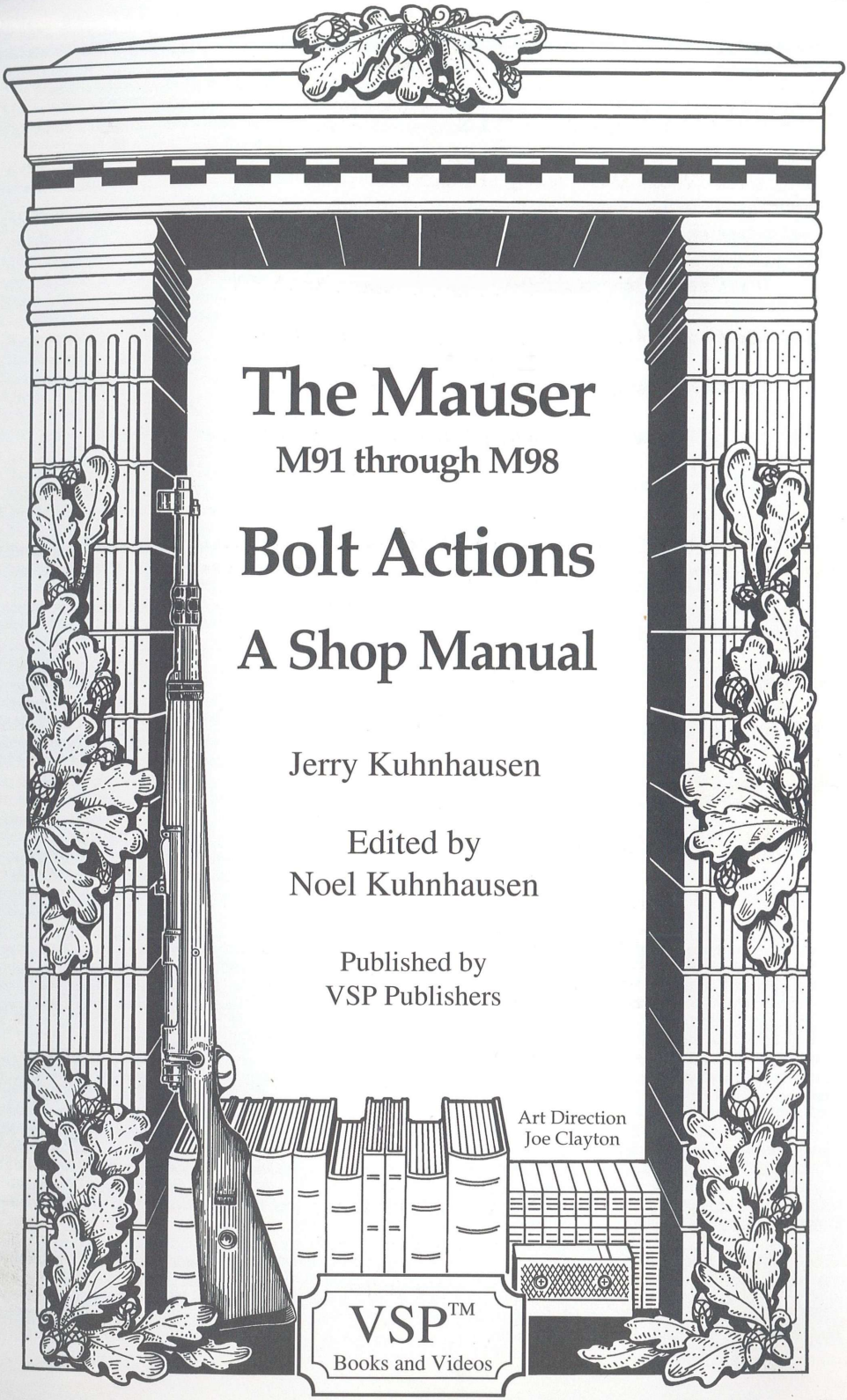
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The Mauser

M91 through M98

Bolt Actions

A Shop Manual

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Years ago, during the period when rifles built with Mauser M91 through M98 actions were in production, Mauser and affiliates provided basic field service data and technical support as a part of military contract requirements. Publications of this type, most technical drawings, and related data, were lost during World War II. Since then, the Mauser company has not published field service manuals on the mechanics or repair of the M91~M98 actions, presumably due to the age of these models, the fact these factory obsolete models are long out of production, and, with current liability in mind, in the belief that field availability of basic mechanical information might allow the untrained and/or unqualified to "fix", or otherwise tinker with a Mauser action or firearm that was not in need of repair in the first place. But, with or without books or service information on the subject, (and the necessary cautions and safety warnings contained therein) tinkerers, being irrepressible, will tinker, just the same. In the absence of detailed, specific model training programs, we believe that professional gunsmiths and riflesmiths will be better served by the data in this shop manual than if no data was available at all. Professionals may be helped even more by the safety warnings, cautions, maximum-minimum specifications and limitations that are given. Additionally, as we see it, it's only fair that nonprofessionals have ready access to, and benefit of, as many of the very same cautions, safety warnings, and specifications as possible. In this way, perhaps a caution might be read and heeded before the fact of an unsafe act, mishap, injury, etc. It is hoped that insight into the mechanical complexity of this subject might serve to convince the nonprofessional to take his Mauser action or rifle to a Mauser qualified riflesmith if, or when, a safety inspection or repair might be needed.

Inside front cover Mauser rifle photos plus the following are from Ludwig Olson's book Mauser Bolt Rifles, Third Edition, courtesy F. Brownell and Son, Publishers, Inc., and Ludwig Olson: Siamese Mauser action ; G33/40 action ; FN single shot M98 action (figure 3); M98 front ring (figure 8); M91 Spanish bolt face (figure 12); and M98 Lange rear sight (figure 143). Ludwig Olson's book, Mauser Bolt Rifles , available from Brownells, Inc., is an excellent reference and suggested reading for gunsmiths and military rifle collectors.

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INTRODUCTION

This manual was reprinted from a series of 24 highly detailed, loose-leaf training manuals originally written by gunsmith Jerry Kuhnhausen for shop training. The author tells us that these manuals soon became exceptionally valuable as ready gunsmithing references when parts identification, parts replacement, and fitting questions came up at the bench. These informative manuals are presented in basically the same step-by-step sequence the professional riflesmith would follow when fitting replacement parts or repairing or rebuilding a rifle at the bench. The printer has resized this manual to standard book size while retaining the author's original detailed instructions, photographs, and illustrations.

The Mauser M91 through M98 Bolt Actions- A Shop Manual covers the Mauser M1891 through M1898 bolt actions in great detail. For purposes of simplified action and parts identification and discussion of the basic similarities and differences between these action mechanisms and action parts, the author groups Mauser action models into M1891 Argentine and Spanish types, M1893~1895 Spanish types (which includes the M94 non-Swedish models), M1894/1896 Swedish types, and M1898 type subgroups. When examined in historical sequence, the importance of the progressive design improvements that led to Mauser's ultimate development of the classic M1898 action becomes even more apparent.

As the title indicates, The Mauser M91 through M98 Bolt Actions- A Shop Manual, is a specialized manual that focuses on the basic mechanics of gunsmithing as it specifically relates to the Mauser bolt actions. Equally specialized riflesmithing subjects such as custom stocking, stock repair, stock finishing, and restoration of collectible military rifles are covered in other Kuhnhausen manuals.

Section I covers action disassembly; detailed receiver, bolt, and parts inspections; parts identification; bore and chamber inspections; headspace checking; parts replacement; correct trigger and safety function; custom triggers and custom trigger adjustment; bolt assembly; correct firing mechanism function; firing pin protrusion, and action reassembly. Emphasis is placed on the importance of serviceable parts and correct bench procedures. General repairs and function checks are also discussed in this section. Safety related subjects such as correct headspace; potentially dangerous bores and chambers; altered or exessively worn cocking pieces and/or safety levers; and oversized firing pin ports are covered in detail. Safety and common sense are stressed throughout. A detailed troubleshooting guide is included at the end of the section.

Section II covers the most often requested Mauser bolt action shop work and discusses some of the finer points of shop and bench gunsmithing techniques. The author devotes attention to receiver preparation for rebarrelling; bolt alterations; bolt and receiver lug lapping; machine work needed for barrel installation or barrel requalification; the importance of concentricity and correct mechanical fit of the receiver/barrel assembly in sporting and varmint rifles, and chamber headspace adjustment in newly installed barrels. Improving receiver/barrel fit and eliminating receiver/barrel stress by glass bedding, and how bedding can directly improve basic accuracy (mechanical repeatability) is also discussed. Other subjects include sight work, scope and base installation, drilling and tapping receivers and barrels for sights, and the importance of correct receiver alignment, sight mounting fixtures, and related tooling.

The Mauser M91 through M98 Bolt Actions- A Shop Manual is a practical repair manual, a package of ready reference information, and the most complete gunsmithing work we have seen to date on Mauser actions. This manual covers virtually everything the gunsmith needs to know about the Mauser M91 through M98 bolt actions.

The Mauser M91 through M98 Bolt Actions- A Brief History

Mauser's Argentine and Spanish contract Models of 1891 evolved from the earlier, basically similar Turkish Model of 1890 and Belgian Model of 1889. Both the 1889 and 1890 models were, in turn, descendants of Mauser's 7.65mm rimmed cartridge experimental rifle of 1888. The 1888 (experimental) Mauser action design represented a major advance over the previous M71/84 rimmed black powder cartridge action. The M91 Spanish rifle/carbine contract specified a cartridge stop plunger and plunger retaining screw installed through the bottom bolt lug to prevent double cartridge feeding. The shell head recess was undercut on the plunger side of M91 Spanish bolts for the same reason. This change repositioned the rotating claw type extractor. See detail in figures 12 and 25.

Although often historically confused, Mauser's 7.65mm rimmed cartridge experimental rifle of 1888 is not the same as the 7.9mm German Rifle Testing Commission Model of 1888. See figure 1. The commission rifle has been mislabeled as the Mauser Model of 1888 probably because of the several design features that were borrowed from Mauser and incorporated into the Commission Model action. The Commission Model, aka GEW 88, was chambered for the then new M1888 7.9x57mm (.318" bullet dia.) rimless type smokeless powder cartridge. This cartridge case is the parent of the Mauser 7mm, 7.65mm, 7.9mm, and most later rimless cartridges.

Mauser's 1892 Spanish contract rifles and carbines included a number of newly patented updates which vastly improved the 1891 design. See M92 illustration in figure 13. The new M92 bolt, extractor, and receiver closely resembled the M93 that was to come, but retained a modified M91 type straight, non-staggered magazine, and thread assembled cocking piece and firing pin. The Mauser M92/93 field test rifle was, in turn, a variant of the model of 1892. As history indicates, the 1892 and 92/93's were both low production, transitional models.

The Mauser 7mm Spanish contract model of 1893 was, basically, the final refinement of the 92 and 92/93 models. The new M93 action had an improved keyed cocking piece and firing pin assembly and was the first Mauser action mass produced with an integral, staggered five round magazine, a feature which became standard on nearly all centerfire bolt action rifles made by Mauser and other manufacturers thereafter. The 7mm Mauser cartridge (7x57mm), first introduced in 1892, became world famous with the M1893 Mauser rifle.

The Spanish M95 carbine (so designated because it was adopted by the Spanish government in 1895) used the same basic action as the M93 rifle. A large number of M95 carbines were assembled on receivers manufactured earlier with 1893 markings and/or with receiver bolt guideways notched to receive M93 square faced bolts. M93 rifles and M95 carbines were manufactured in Germany and Spain. An oddity of some Spanish manufactured M93, M95, and certain other barrels is that they weren't made in a single piece. The liners installed in these barrels are seldom visible at the muzzle.

Most M93 Spanish rifles were converted to 7.9mm before, or during, WWII. Many Spanish M93 short rifles and M95 carbines were later rebarrelled and chambered to fire the 7.62mm CETME cartridge and were redesignated as 1916 Models. Large quantities of these M93/M95 to M1916 7.62mm CETME conversions have been imported into the U.S. and several other countries. The 7.62 CETME cartridge generates a much lower gas pressure than the 7.62x51mm NATO or .308 Win. cartridges. See caution on page 85

It is important to note that, except for a few small details, non-Swedish type M94 actions, such as those used in the 7mm Brazilian Model of 1894, are virtually identical to the M93 Spanish contract rifle action. The 7mm Chilean contract model of 1895, and other various 1895 models, also used near duplicates of the Mauser M93 action.

The M94 Swedish model carbine was a further refinement of the basic M93 Mauser design and featured an extra long knurled cocking piece, a bolt guide rib, and two bolt gas escape ports. Although M94/M96 Swedish type Mauser bolts and receivers are generally similar to earlier Mauser small ring bolts and receivers, they are dimensionally different and will not interchange with M91-M92 Argentine/Spanish type, M93-M95 Spanish type, M94-M95 South American type, or any other small or large ring Mauser.

The M96 Swedish rifle used the same action as the Swedish M94 carbine. Both models were chambered for the 6.5mm (6.5x55mm) Swedish service cartridge. The M94 and M96 Swedish models were manufactured in Germany and Sweden. In overall quality and appearance, Swedish Mauser actions are the best made and heat treated of all the contract and license manufactured small ring Mausers.

The Mauser model of 1898 evolved from the M94 and M96 Swedish models, Mauser's patents of 1895, and the successful configuration of the experimental rifle of 1896. Estimates of the total number of M91 through M98 rifles, short rifles, carbines, commercial models, and variants that have been manufactured to date range from 100 million to well over 125 million units. Some authorities indicate this is a conservative figure.

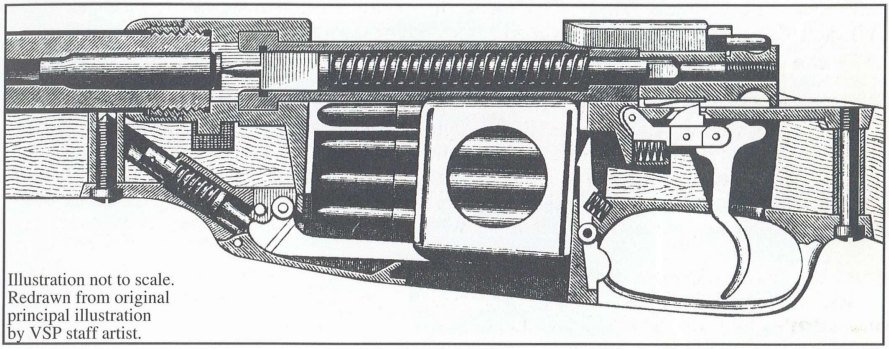


Illustration not to scale.
Redrawn from original
principal illustration
by VSP staff artist.

Figure 1- The half-sectional illustration, above, shows mechanical features of the German Military Commission Infantry Rifle Model of 1888 (so designated on adoption by the German government in 1888). This drawing is included here because the Commission Model, or GEW 88, has often been confused with Mauser produced rifles- even to the extent that it has been incorrectly called the Mauser M88 rifle. The only 1888 designated rifle made by Mauser was an experimental 7.65mm rimmed cartridge model which was never mass produced. Considering that a number of features were borrowed from earlier Mauser designs, the mislabeling of the Commission 88 rifle is, to some extent, understandable.

Mislabeling didn't end with the M88 Commission Rifle. The commission also designed the M88 7.9mm infantry rifle cartridge that, since its inception, has been variously called the 7.9mm, 7.9x57mm, 8x57mm, and/or 8mm Mauser cartridge, as if it had actually been designed by Mauser.

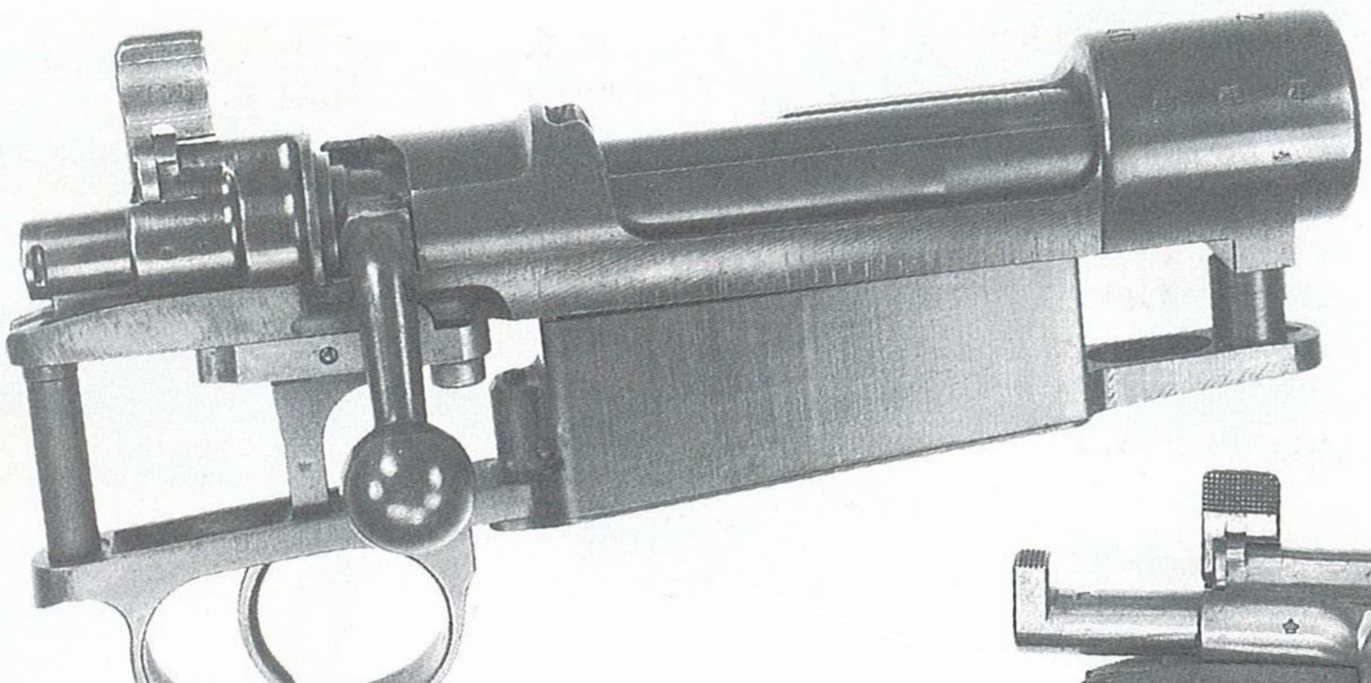
Because the 7.9mm M88 infantry rifle cartridge was adopted by the German military, and because its rimless, tapered 57mm case permitted staggered magazine loading and easy extraction at higher operating pressures, it became the design basis for the 8x51mm, 7.65x53mm, 7x57mm, 6.5x57mm, 6.5x55mm, 6.5x54mm, 6x57mm, and many other rimless cartridges that followed.

The original 7.9mm M88 cartridge was revised by the German military in 1903. The new service round retained the standard 7.9x57mm cartridge case, but included a newly designed pointed ("S" type) bullet. The new "S" bullet was larger in diameter than the original (.323" vs. .318"). The new round was also loaded to a higher pressure. Barrel changes to accommodate the larger diameter "S" type bullet began with issue of the new ammunition in 1905. **Warning**: if later (.323" bullet dia.) ammunition is fired in an earlier, smaller diameter barrel, dangerous pressures will result. Although most rifles barrelled and chambered for the early, small dia. 7.9mm bullet have long since been converted, a few are still around. Cerrosafe cast and measure all unknown bores and chambers before firing.

Mauser M91~M98 Rifles and Carbines and Major Model Variations-

Model Date Designation	Government Made For	Manufacturing Company	Caliber & Cartridge	Commercial Cartridge
M1891 Rifle	Argentina	Loewe, Germany	7.65mm Mauser	7.65x53mm
M1891 Carbine	Argentina	Loewe, Germany	7.65mm Mauser	7.65x53mm
M1891 Rifle	Spain	Mauser, Germany	7.65mm Mauser	7.65x53mm
M1891 Carbine	Spain	Loewe, Germany	7.65mm Mauser	7.65x53mm
M1892 Rifle	Spain	Mauser, Germany	7mm Mauser	7x57mm
M92/93 Carbine	Spain	Mauser, Germany	7.65mm Mauser	7.65x53mm
M1893 Rifle	Spain	Mauser, Germany	7mm Mauser	7x57mm
M1893 Rifle	Spain	Loewe, Germany	7mm Mauser	7x57mm
M1893 Rifle	Spain	FAO, Spain	7mm Mauser	7x57mm
M1893 Short Rifle	Spain	IGC, Spain	7mm Mauser	7x57mm
M1893 Short Rifle	Spain	FAO, Spain	7mm Mauser	7x57mm
M1893 Rifle	Turkey	Mauser, Germany	7.65mm Mauser	7.65x55mm
M1894 Rifle	Brazil	Loewe, Germany	7mm Mauser	7x57mm
M1894 Rifle	Brazil	FN, Belgium	7mm Mauser	7x57mm
M1894 Carbine	Sweden	Mauser, Germany	6.5mm Swedish	6.5x55mm
M1894 Carbine	Sweden	Carl Gustafs, Sweden	6.5mm Swedish	6.5x55mm
M1895 Carbine	Spain	Loewe, IGC, etc.	7mm Mauser	7x57mm
M1895 Rifle	Mexico	Loewe, DWM, etc.	7mm Mauser	7x57mm
M1895 Rifle	Venezuela	Loewe, DWM, etc.	7mm Mauser	7x57mm
M1895 Rifle	South Africa	DWM, Germany	7mm Mauser	7x57mm
M1895 Rifle	Uruguay	Loewe, DWM, etc.	7mm Mauser	7 x57mm
M1895 Rifle	Chile	Loewe, Germany	7mm Mauser	7x57mm
M1895 Rifle	Chile	DWM, Germany	7mm Mauser	7x57mm
M1895 Rifle	Persia	Various manufacturers	7mm Mauser	7x57mm
M1895 Rifle	China	Loewe, DWM, etc.	7mm Mauser	7x57mm
M1896 Rifle	Sweden	Mauser, Germany	6.5 Swedish	6.5x55mm
M1896 Rifle	Sweden	Carl Gustafs, Sweden	6.5 Swedish	6.5x55mm
M1896 Rifle	Luxembourg	Mauser, Germany	6.5 Mauser	6.5x55mm
M1896 Exp. Rifle	Germany	Mauser, Germany	6mm M96	———
M88/97 Exp. Rifle	Germany	Mauser, Germany	7.9mm Mauser	8x57mm
M1898 Rifle	Germany	See note 1	7.9mm Mauser	8x57mm
M1898 Carbine	Germany	See note 2	7.9mm Mauser	8x57mm
M98a Carbine	Germany	See note 2	7.9mm Mauser	8x57mm
M98b Carbine	Germany	Various manufacturers	7.9mm Mauser	8x57mm
M98K Carbine	Germany	See note 3	7.9mm Mauser	8x57mm
M98K Refurbished	Various countries	See note 4	Assorted	———
M1902	Mexico	See note 5	7mm Mauser	7x57mm
M1903	Turkey	See note 5	7.65mm Mauser	7.65x53mm
M1903	Siam	Mauser/Tokyo Arsenal	8mm T45/66 Siam	———
M1904 Mil/Comml.	Various countries	See note 5	See note 6	———
M1907	China	Mauser, Germany	6.8mm Chinese	———
M1907 Mil/Comml.	Various countries	See note 5	See note 6	———
M1909 Short Action	Peru	Mauser, Germany	7mm Mauser	7x57mm
M1909 Mil/Comml.	Various countries	See note 5	See note 6	———
M1910	Mexico	FNA, Mexico	7mm Mauser	7x57mm
M1910 Mil/Comml.	Various countries	See note 5	See note 6	———
M1912 Mil/Comml.	Various countries	See note 5	See note 6	———
M1922 Mil/Comml.	Various countries	See note 5	See note 6	———
M1924 Mil/Comml.	Various countries	See note 5	See note 6	———
M1927	Paraguay	FAO, Spain	Assorted	———
M1929	Poland	Radom, Poland	7.9mm Mauser	8x57mm
M1930 Std. Modell	Various customers	Assorted	———	———
M1930 Mil/Comml.	Various countries	See note 5	See note 6	———
M1933 Short Rifle	Czech. Police	CZ, Czechoslovakia	7.9mm Mauser	8x57mm
M1935 Mil/Comml.	Various countries	See note 5	See note 6	———
M1936	Mexico	FNA, Mexico	7mm Mauser	———
M1943	Spain	La Coruna, Spain	7.9mm Mauser	8x57mm
G33/40	Germany	See note 3	7.9mm Mauser	8x57mm
M1950	Belgium	FN, Belgium	.30-1906	.30-06
M1954	Mexico	FNA, Mexico	.30-1906	.30-06

Note 1. Manufactured at Spandau, Erfurt, Danzig, and Amberg arsenals and also on contract by Mauser, DWM, Schilling, Haenel, J.P Sauer, Oberspree Kornbusch, Simpson, and possibly others.
Note 2. Manufactured at German government arsenals only.
Note 3. Manufactured at numerous factories. See Ludwig Olson's Mauser Bolt Rifles for manufacturer code details.
Note 4. Large quantities of captured WWII M98K carbines and other M98's have been rebarrelled and otherwise reconditioned by various government arsenals and companies. Rifles with M98 type actions were also produced for a period after WWII by FN and Husqvarna. Large quantities of M98 parts were also made by FN after WWII.
Note 5. These more or less standardized rifles and carbines were manufactured with M98 type actions by Mauser, DWM, Steyr, and later by FN and other factories including CZ in Czechoslovakia, and were sold in assorted calibers to various governments, police organizations, and wholesale customers. Most contract rifles were made with standard dimension M98 actions. Variations usually had special features or small changes to standard specifications.
Note 6. Commercial and military models of 1904~1935 were available in a wide range of cartridges, on special order. Some South American M98 rifles were converted to .30-06 after WWII. Due to age and unknown maintenance history, all M91~M98 rifles and actions should be considered unsafe, until serviceability has been determined by a Mauser qualified gunsmith.



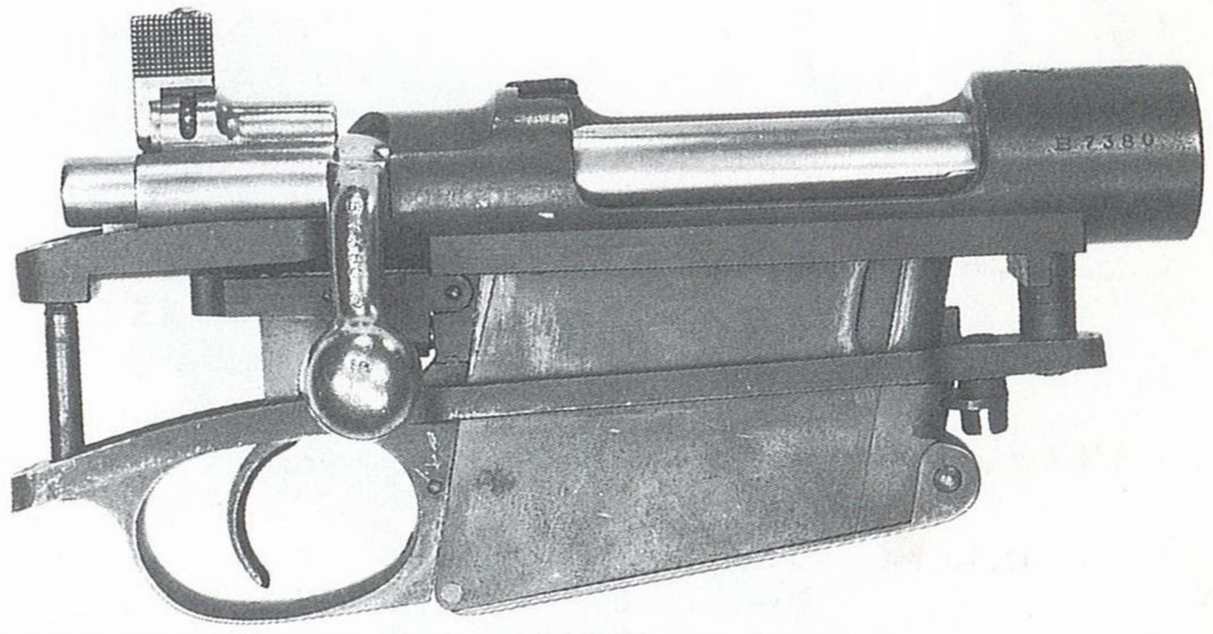
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M98K
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(Argentine)
Action

Figure 2- Shows examples of the four most common Mauser military actions. The large ring (1.410" -1.420" diameter) German military M98K action, shown at top, was stamped 42 at the top front of the receiver ring to identify manufacture by Mauser. The front ring is also stamped 1940 to designate the year of manufacture. Later M98K's were stamped with only two digit manufacturing date codes. M98K actions measure 8.75" overall and are considered standard length. Oberndorf commercial M98 sporter actions were made in standard length, short length (8.5"), long or magnum length (9.25"), and in several special short bolt/short magazine military and commercial intermediate lengths especially for 7x57mm or shorter cartridges. Bolts in these models run approx. .200" to .250"shorter than standard. See Mauser action dimension table on pages 214 and 215. Other military and commercial M98 variations are discussed in Ludwig Olson's excellent book Mauser Bolt Rifles, available from Brownells, Inc. The M94 Swedish Mauser action, just below the M98, was also manufactured by Mauser and is date stamped 1900. M94 and M96 Swedish Mausers were made in Germany and Sweden; original parts are identified by a Swedish crown imprint. M94-M96 bolts are slightly longer than previous model bolts and are easily identified by their integral guide ribs and top and side gas ports. The M95 Spanish Mauser action , in third position, was manufactured in Spain and has no date stamp or left side manufacturer imprint. Although many Spanish made M93~M95 actions (including those used on later conversions) do not have model, manufacturer, or government crest imprints, most are easily identified by the bolt guide rib in the left receiver lugway, their generally rougher machine work, and markings (or lack of markings). South American and other government contract Mauser M94 (non-Swedish) and Mauser M95 actions are stamped to identify the model, manufacturer, and government. These rifles were made in Germany, and are virtually identical in design to the Spanish M93. The M91 Argentine action, at bottom, was manufactured in Germany by DWM. Except for bolt detail changes, the M91 Spanish action is basically the same as the Argentine.

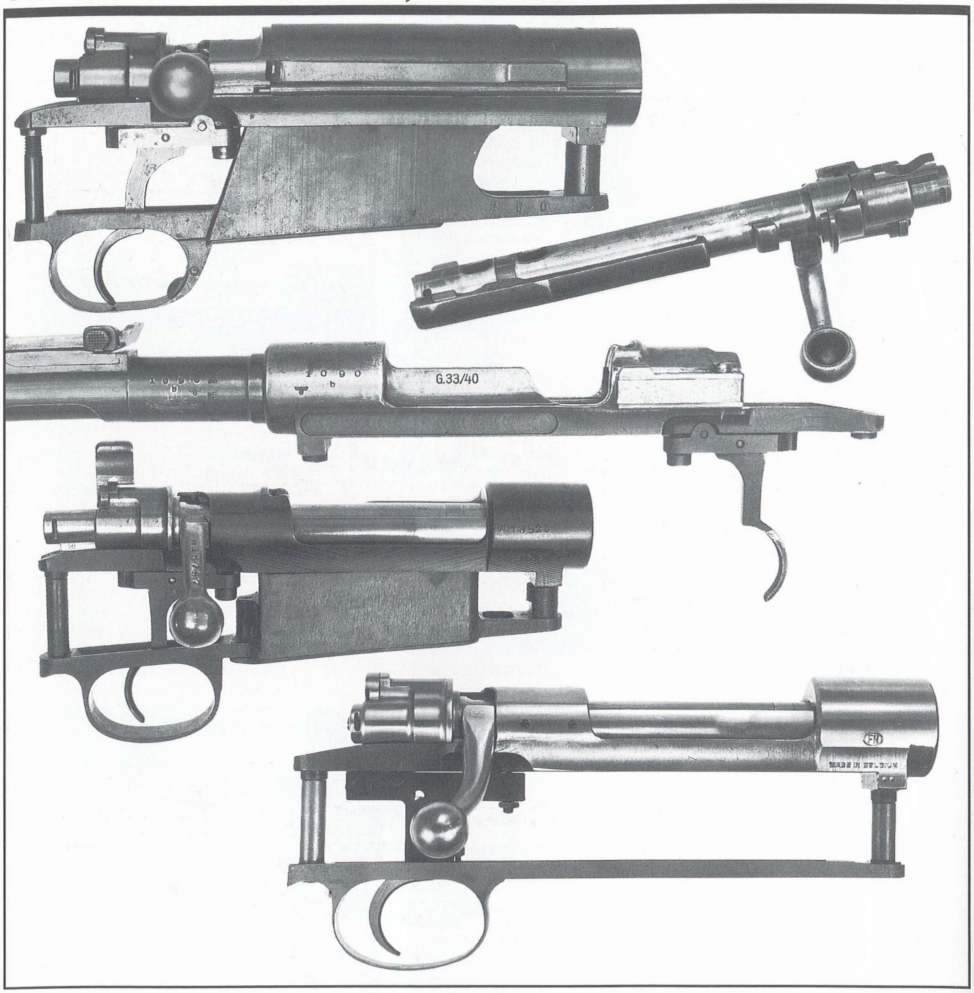
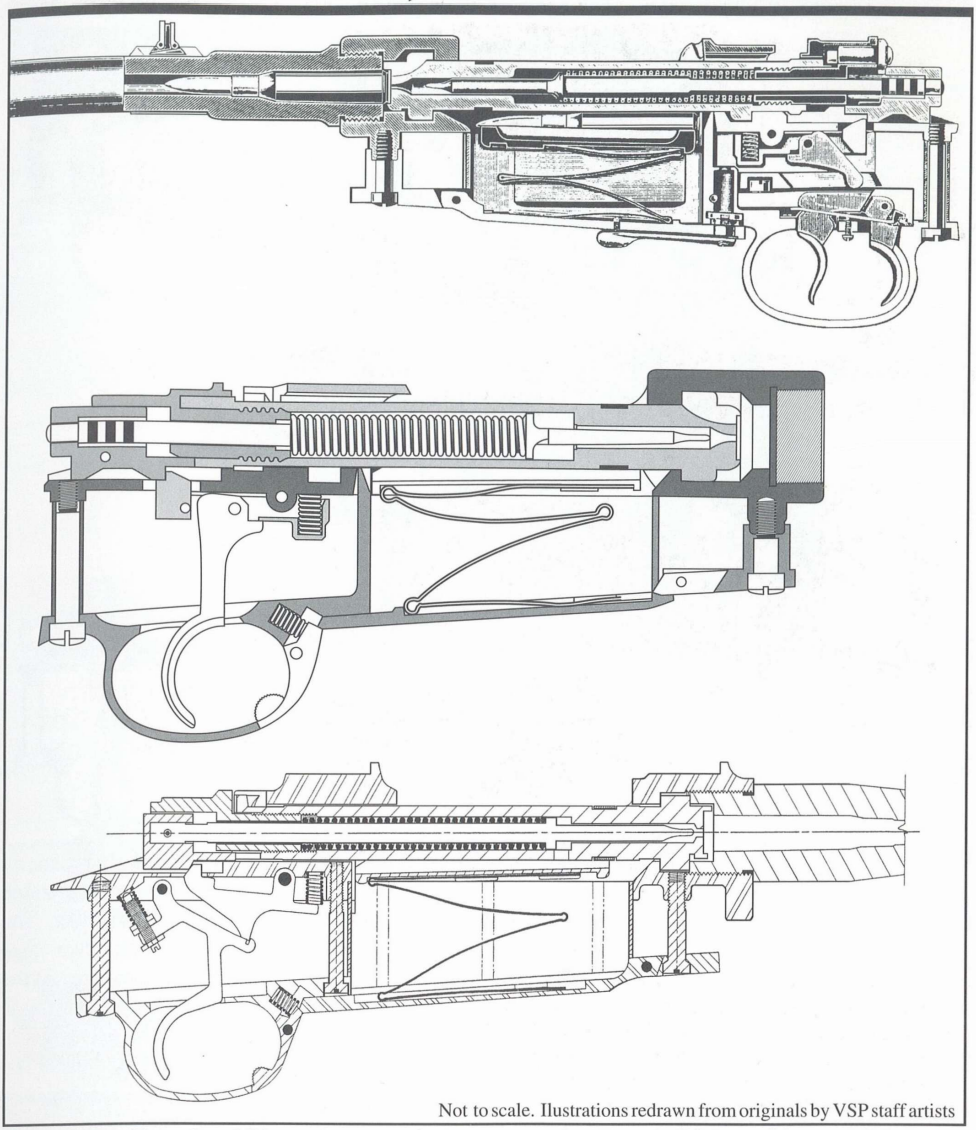


Figure 3- Shows examples of four different M98 action variations. The Siamese Mauser action, at top, is shown with the dust/mud cover in closed position. The trigger guard, magazine housing, magazine follower and extractor were redesigned to enable the action to feed and extract Siamese T45 and T66 8mm rimmed military cartridges. Enlarging the magazine well required a setback trigger, as shown above. Note the Oberndorf commercial sporter type magazine floorplate release inside the trigger guard. Although the Siamese Mauser action is not specifically covered in this manual, it is shown here for purposes of identification and comparison.

The G33/40 barrelled action, just below, is a lightweight version of the standard M98. Note the receiver and bolt knob lightening cuts. The G33/40 is a small ring M98 variation (1.295"-1.300" ring diameter). Major barrel thread dia. is .980", as with the earlier small ring M91~M96 Mauser models.

The Yugoslavian M24 action, in third position, is a large ring diameter example of the intermediate length category discussed in fig. 2. In the action shown, the front ring measures approximately 1.615" long. Receiver overall length is 8.5", making this action 1/4" shorter than standard. Intermediate length actions such as the M1909 Peruvian and M24, above, are sometimes referred to as short actions but are not. See pages 214 and 215. Oberndorf manufactured most commercial intermediate and true short (kurz) M98 actions to customer specification. Many were made with small receiver rings.

The F.N. commercial M98 single shot action, at bottom, has a solid receiver (no magazine opening), is more rigid than a standard action, and can be bedded full length.



Not to scale. Ilustrations redrawn from originals by VSP staff artists

Figure 4- Half sectional illustration, at top, shows an early Oberndorf Mauser commercial sporter action with military type firing pin safety, adjustable double set trigger, and hinged magazine floor plate with lever type release. The sectional illustration, just below, shows a commercial M98 sporter action typical of those made primarily by FN. The rear bridge in these receivers was not slotted for stripper clip loading. These actions were assembled with military or sporter type triggers, military trigger guards, or trigger guards with Oberndorf type hinged button release floorplates. Bolt assemblies were furnished with military type bolt sleeves and firing pin safety levers or with streamlined commercial bolt sleeves which required a separate side mounted trigger safety lever with bolt lock. The bottom half sectional illustration shows a Kimber M89 Mauser/M70 Winchester style action. The Kimber M89 action is shown here for comparison. Pre-1964 M70 Winchester actions were variations on the Mauser bolt action design. The Kimber M89 incorporates basic M70 trigger, safety, and receiver recoil lug features, but has an external bolt stop, hinged floorplate, and square front and rear receiver bridge configuration reminiscent of the expensive early Oberndorf commercial sporter actions.

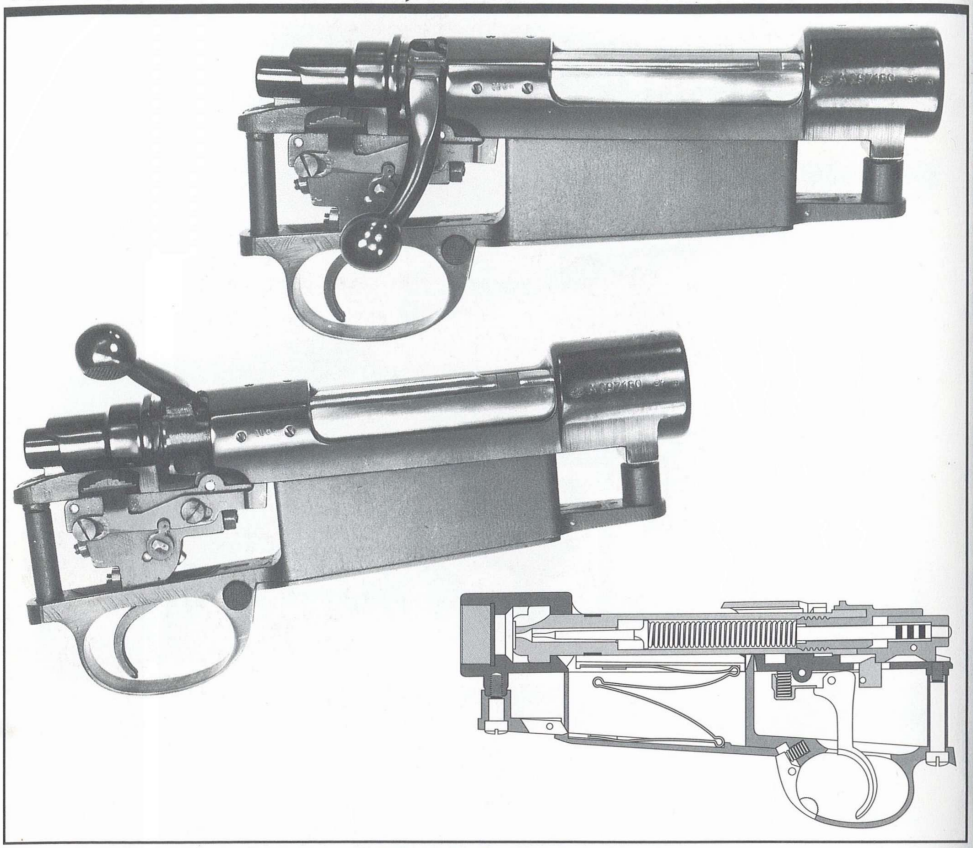


Figure 5- Shows views of a late style **Mark X Mauser** M98 type commercial sporting action made by Zastava in Yugoslavia and imported by **Interarms, Ltd.** The bolt open view shows an adjustable sporter trigger assembly with a trigger block type safety and side mounted safety/bolt lock lever. The half sectional illustration, at bottom, shows a commercial M98 action variation featuring a two-stage standard military trigger and Oberndorf style inside trigger guard magazine floorplate release. At the time of writing, standard M98 length (8 3/4" O.A.L.) Mark X actions were being offered in a single shot version (solid bottom receiver without magazine- similar to the FN single shot action shown in figure 4) and in four other variations for cartridge lengths from 7x57mm to .375 H&H Magnum. The four variations all have receivers that are basic standard M98 length. Receiver cartridge openings and magazine boxes, however, are sized to accommodate the cartridge range the particular action variation was made for. A mini version (7 1/8" O.A.L.) with a Sako style extractor for .222 and .223 Remington cartridges is also available.

Most Mark X parts and correctly matched parts assemblies (speed lock firing mechanisms and bolts are an example) can be installed in a standard length M98 military Mauser action with careful fitting and function checking by a qualified gunsmith. However, regardless of dimensional similarity, Mark X parts must not be considered interchangeable "drop-in" parts for Mauser military M98 actions.

Note 1: Bolt exchanges or replacements always affect headspace. Headspace must be gauged and the barrel and chamber requalified to correct headspace as a necessary part of bolt replacement work.

Note 2: Mark X M98 style actions are made from alloy steels rather than the low/medium carbon steels used in M98 actions made by Mauser and European affiliates before and during WW II. Heat treats and hardnesses discussed in this book relate specifically to Mauser low/medium carbon steel bolts and receivers. Alloy steels and higher carbon steels respond differently to heat treatment. Acceptable hardness in low/medium carbon steels would not be acceptable in high carbon or alloy steels.

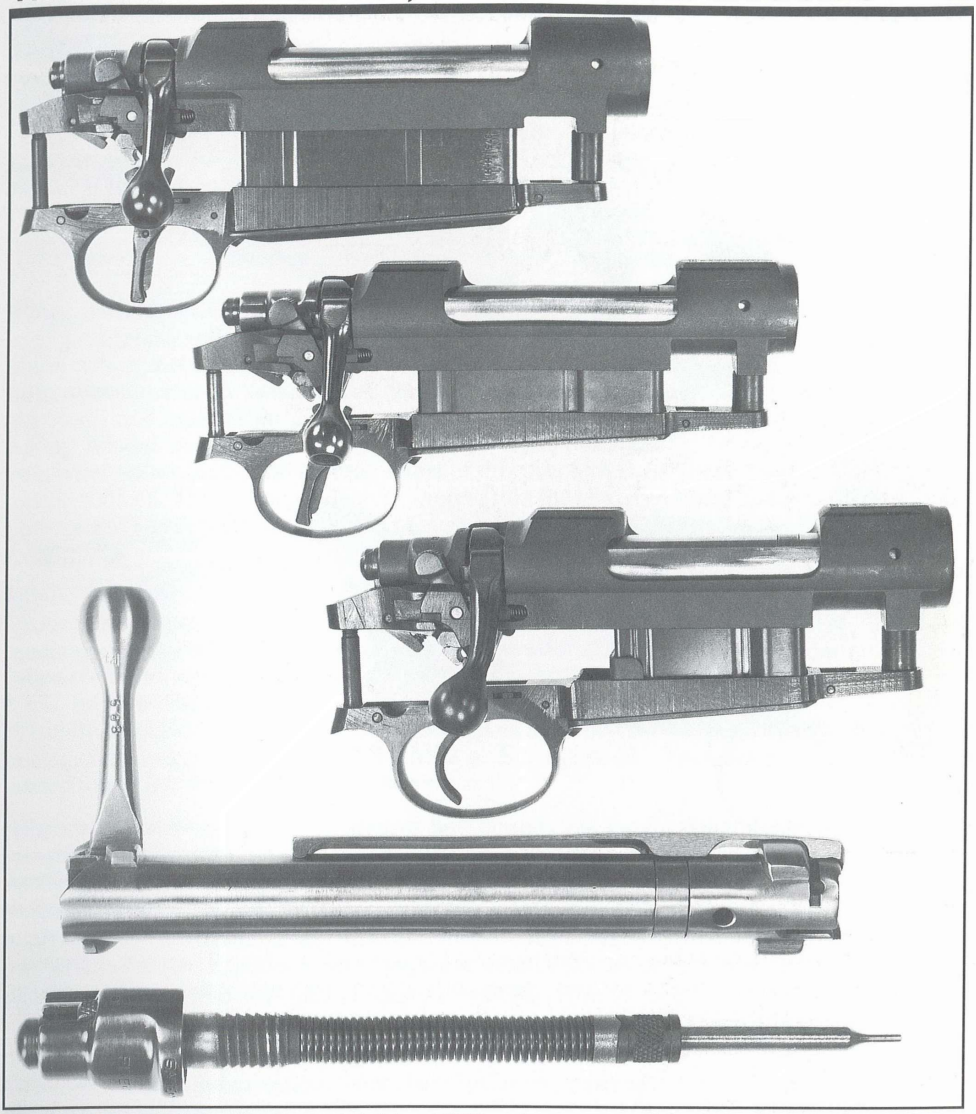


Figure 6- Shows three Brno square bridge, ZZK series, commercial Mauser type actions. These actions are considerably different than the basically standard M98 actions that were made in Czechoslovakia before and during WWII. ZZK actions are shown here for comparison and because they provide an example of the continuing evolution of the basic M98 design. Shown from top to bottom are: the ZZK 602 long action (for .375 H&H magnum length cartridges, approx. 9 1/4" OAL), the ZZK 600 standard action (handles .30-06 length cartridges, approx. 8 3/4" OAL), and the ZZK 601 short action (for .222 Rem. through .308 length cartridges, approx. 8 1/4" OAL). Although ZZK actions are virtually the same length as the earlier Oberndorf commercial sporter actions, many features, including trigger, safety, ejector system, and firing mechanisms are different. The firing mechanism is shown removed from a typical ZZK bolt, below. Among the basic differences: the bolt safety lug and extractor cam are located further back; the bolt body has a single gas port; the side of the bolt is slotted for the ejector (instead of the top locking lug). The redesigned bolt shroud has a bolt disassembly button on the side, and the redesigned firing pin has a screw-on spring retainer and keeper, etc. The cocking piece is mechanically fixed to the firing pin. Needless to say, ZZK action parts do not interchange with Mauser action parts.

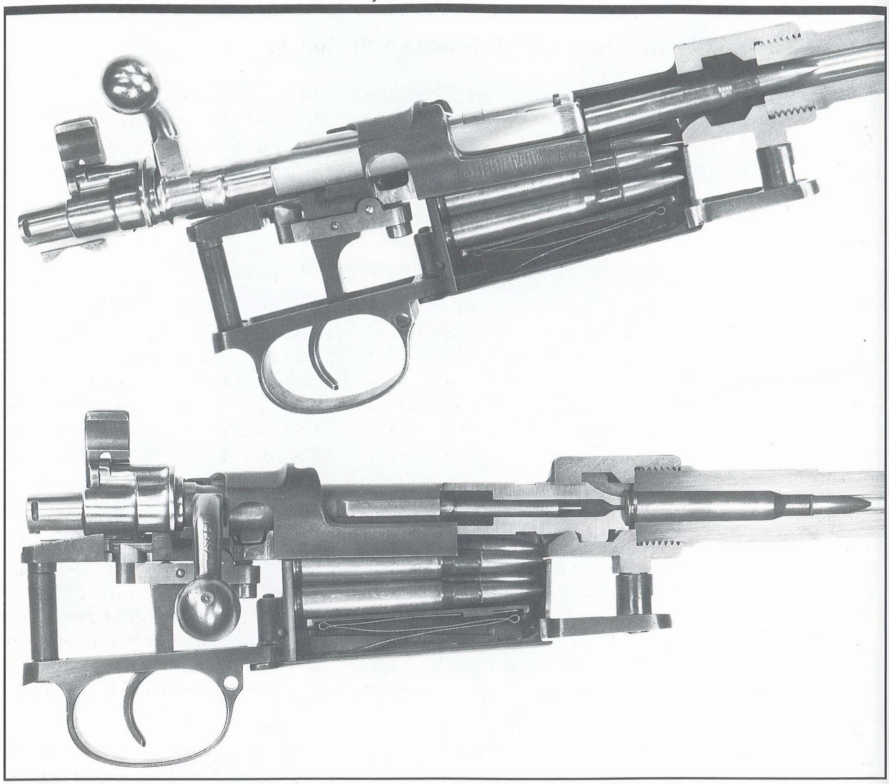


Figure 7- Shows cutaway views of Mauser military M98 actions. The action, at top, shows a dummy round as it is being stripped from the magazine by forward movement of the bolt. The cartridge is just at the "breakover" point where the rim begins to move up under the extractor claw and into firing position. In the cutaway action below, the dummy cartridge is fully chambered and the bolt is locked. The six basic factors that control or affect smooth magazine feeding and cartridge breakover are: cartridge diameter (particularly at the shoulder); overall cartridge length; magazine rail width and contour; receiver ramp contour and condition; rim clearance at the extractor claw; and the condition of the extractor and bolt face. The firing pin safety levers in both cutaway M98 actions are shown straight up in the disassembly detent. With the safety lever in this position, the firing mechanism is retained as it would be if the safety was on; the difference is that the bolt is not locked closed and can be cycled. Place the safety lever in this position when removing a loaded cartridge from the chamber.

Cutaway rifle actions are particularly useful in the shop as training aids and references. Virtually every parts function and interaction can be visibly demonstrated, including military type firing pin safety operation and cocking piece/sear disengagement and re-engagement; vertical cocking piece/sear engagement; bolt and receiver lug engagement; and M98 internal firing pin safety operation. Reference points for headspace gauge measurement become apparent when headspace gauges are installed in cutaway actions, as above. See headspace, figures 74-76.

Standard dimension M98 receivers in unaltered and serviceable condition are strong enough to handle most commercially loaded cartridges. The practice of modifying the receivers' cartridge feed ramp by cutting it forward and/or deeper to accommodate the feeding of longer cartridges is not recommended. Removing metal from the area behind the bottom receiver lug weakens receivers to greater or lesser degree. See figure 187.

About Gunsmithing the Mauser M91 through M98 Bolt Actions-

Although some information is available on rebarrelling military rifle actions and converting military rifles into sporters, very little material has been published on the subjects of servicing, parts inspection, basic repairs, and action rebuilding for any type or particular brand of bolt action rifle. Considering the great quantities that have been manufactured (see "A Brief History" on pages 8 and 9), it is surprising that almost zero gunsmithing and general repair information has ever been made available to gunsmiths, or the public, on the Mauser M91, M92, M93, M94, M95, M96, and M98 bolt actions.

From a field service viewpoint, the M91 through M98 Mauser actions are basically straightforward and mechanically uncomplicated. Nonetheless, a lack of familiarity with these action mechanisms, and the design/function differences between them, can lead to misunderstanding in two critical areas: troubleshooting and locating basic mechanical problems and making the correct repair; and the importance of the basic mechanical and safety related factors that would determine nonserviceabililty of individual M91~M98 receivers, action parts, and barrels. Most of this problem is caused by lack of available data on the subject. The balance, however, stems from the tendency some have to generalize and lump these similar, but quite different, actions together, as if all were the same.

The fact is that Mauser M91~M98 actions divide into M91/M92 Argentine, Spanish, etc. types; M93/M95 Spanish types (the M94 non-Swedish Mausers are in the M93/M95 type group); M94/M96 Swedish types, and the various M98's. These actions are better and easier understood only when grouped in this way. Large quantities of M91 (Argentine contract) Mausers were imported to the U.S. M92 (Spanish contract) Mausers are uncommon in the U.S., but are discussed here briefly because of their special place in Mauser evolution. Visually, the M92's appear to be a transitional mixture of M91 and M93 design features with a magazine update found only on the M92's. See figure 13. This makes the M92 a partial exception to the M91/M92 group above.

History has demonstrated that Mauser bolt actions are tough, dependable, and extremely durable. But, having said that, also keep in mind that the majority of the Mauser bolt actions made have been in service for well over 50 years. Most M91's left the factory around 100 years ago. Although age, by itself, generally isn't a serious negative as far as most Mauser actions are concerned, time does "set" or weaken compressed springs and serve to compound other negatives such as the effects of poor maintenance, abnormal wear, weather exposure, general mistreatment, and other forms of damage. For these, and the reasons below, parts identification; parts inspection; and determination of basic receiver, bolt, and action parts serviceabililty are discussed in detail throughout this manual.

M98K's were made in various plants in Germany and occupied Europe during World War II. With the combined effects of increased bombing raids and partisan and slave labor sabotage, M98K quality control slipped in 1942 and grew even worse into 1943. Some M98K receivers, bolts, barrels, and action parts made in 1942 and thereafter are questionable, and in some cases, even potentially unsafe. M98K parts made after 1942, including bolts and receivers, are generally of much lower quality and are frequently found dimensionally off-tolerance and with skipped machining steps. In other instances, some components appear to have been made from various subsitituted steels. Heat treats vary considerably as well. Late M98K bolts and receivers have been found that were extremely soft, or at the opposite extreme, over carburized to the extent that they were brittle.

For these and other reasons, the condition of any barrelled action can't be taken for granted just because exterior or interior surfaces appear relatively unworn or unpitted. Less obvious but equally important factors are the correctness of action parts; combined receiver and parts tolerances; and the condition of the receiver's lug engagement surfaces and possible presence of lug surface setback (bolt lug indentations). Receiver lug area setback is hard to see without removing the barrel. See page 69.

Other important factors to consider when servicing, repairing, restoring, or rebuilding rifles- and particularly when sporterizing and/or rebarrelling Mauser rifles and Mauser actions- is whether or not the action to be used is in good enough condition to warrant the cost of rebarrelling or other work. It's a practical matter of project cost or investment versus the quality of the action. Another question would be: is the action model suitable and can it handle the pressure range of the intended cartridge. In this connection, I would suggest limiting rebarrelling and chambering, sporting conversions, and custom rifle building to the strict use of only two Mauser actions:

A. The large ring commercial and military M98 Mauser actions for standard pressure commercial sporting cartridges. See custom rifle action comments in table on pages 214 and 215. If an M98K action is to be used, select only those made before mid-1942 to be safe.

B. Small ring Mausers for low pressure commercial sporting cartridges such as the 7x57mm Mauser. Although German made M93~M95 actions are often found in serviceable condition, I suggest using only M94~M96 Swedish type actions. The quality of one of these actions in excellent condition speaks for itself. Spanish made M93 and M95 actions are typically much too soft and are not suggested.

Although it may seem conservative to some, keep in mind that the original peak operating pressure for the 7x57mm military cartridge in German made small ring Mauser rifles was approx. 42,000 psi., or roughly about 37,000 cup. Original peak operating pressure for the later, higher pressure "S" version of the 7.9x57mm military cartridge in large ring M98 Mauser rifles (with "S" type chambers and bores) was less than 47,000 psi.

Warning: This is historical data only, not a pressure specification or recommendation.

As with all firearms, and Mauser actions are no exception, the best way to study action function is through careful observation of correct and incorrect operation of the internal action parts. Cutaway gunsmith training rifles, as shown in figure 7 and throughout this manual, help dispel incorrect theories and guesswork by allowing the riflesmith to see the parts in question interact and thus determine exactly where a problem is and what is required to solve it.

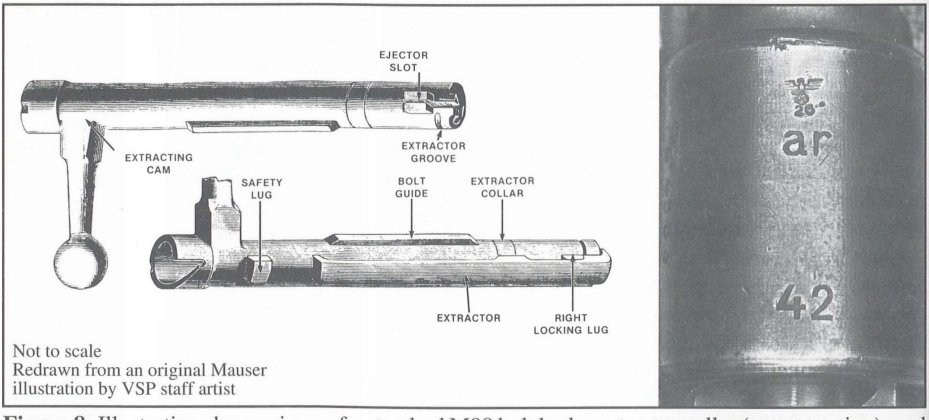


Figure 8- Illustration shows views of a standard M98 bolt body, extractor collar (extractor ring), and nonrotating type extractor. The quality of late M98K bolt bodies ranged from rough, but serviceable, to poor or worse. Previously standard M98 bolt features such as the longitudinal bolt guide rib, shown above, and elongated gas vent ports were deleted on many late production M98K bolts. Bolt lug hardness varied considerably, as well. Ordnance acceptance stamps of the type shown on the receiver ring, at right, appear on Mauser rifles and major rifle components manufactured somewhat before and during WWII. Be wary of late M98K bolts and receivers. That a late major M98K part in apparently original condition does not have an acceptance mark could mean one of four things: (1) the item was not yet inspected and ordnance accepted; (2) the item was rejected but was used anyway; (3) the acceptance mark has been ground or polished off; or (4) the item is not an M98K part, but was actually made earlier or later.

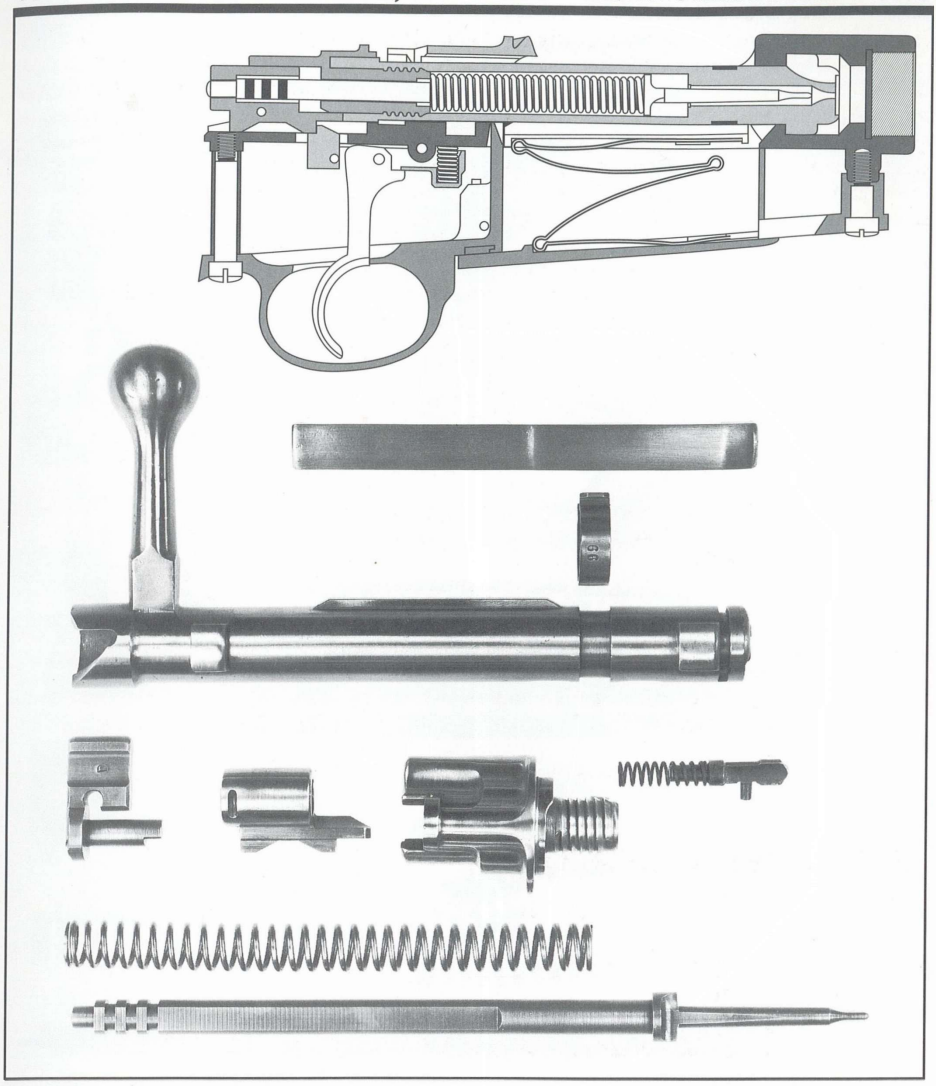


Figure 9- Half sectional standard M98 military action illustration, above, and disassembled military configuration M98 bolt, below, identify important M98 action features and differences as compared to earlier Mauser actions. Major features that identify a standard M98 action include a large (approx. 1.410"-1.420" diameter) standard front receiver ring; correspondingly thicker receiver walls, action rails and recoil lug; an updated bolt sleeve with sleeve lock plunger assembly; a cocking piece with cock on opening ramp extension; an updated bolt body with a larger diameter cock on opening cam; a third safety lug, and an updated firing pin with safety stop shoulder extensions. M98 subtypes include the small ring M98a, M98/32, VZ33, and G33/40 models. Front rings on these receivers typically measure approx. 1.290"-1.300" in diameter. Other departures from standard M98 dimensions include the assorted short bolt and magazine intermediate models and the small ring .980" barrel thread variants made on contract for world governments. **Note**: Some early M98's are found with bolt sleeves without lock plungers and firing pins without safety lug shoulders. These parts originated on early Oberndorf commercial sporting rifle actions and must not be installed in later standard bolts.

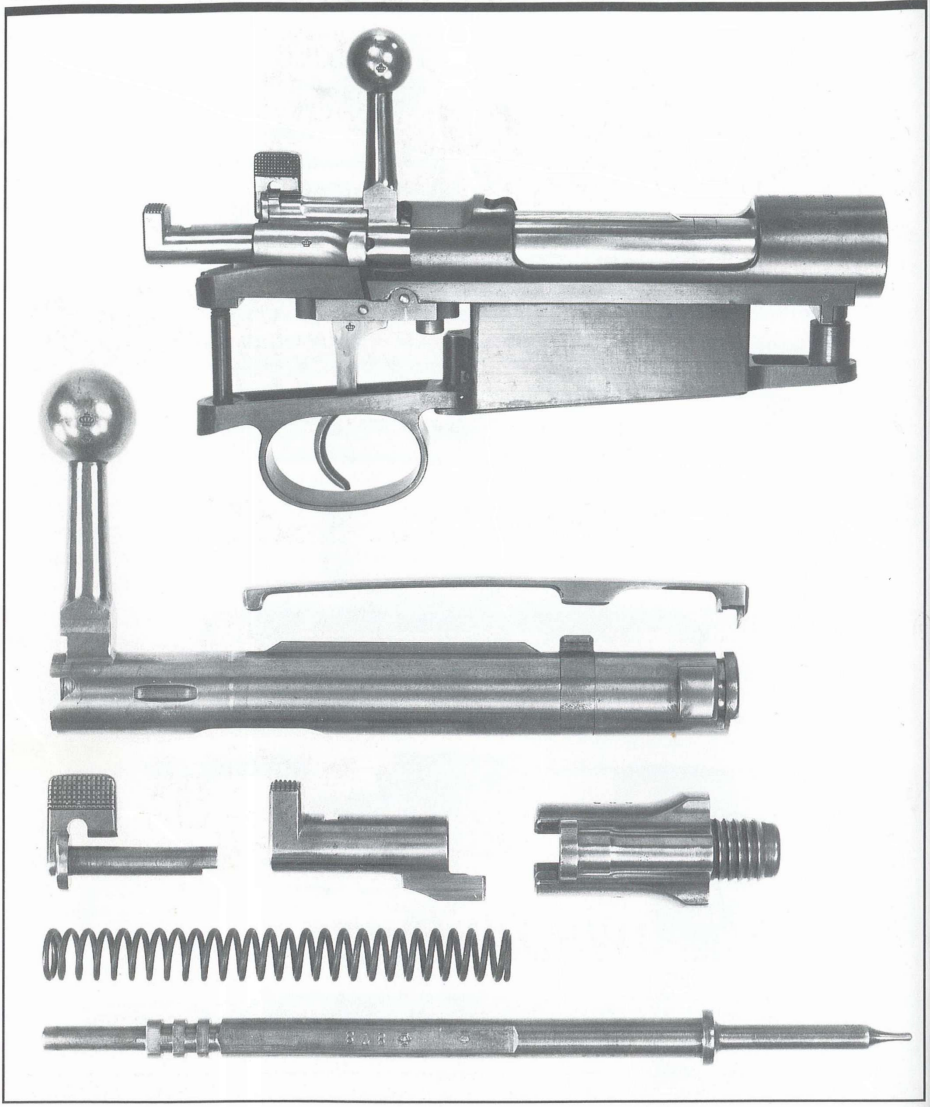


Figure 10- Shows a Swedish M94 Mauser action, above. A disassembled M94/M96 Swedish type bolt is shown below to identify some of the major differences between the M94/M96 Swedish Mauser actions and earlier and later Mauser action models. The M94/M96 Swedish Mauser cocking piece has a knurled L-shaped thumb knob with firing pin safety lever engagement notch milled just forward of the thumb knob. This feature is most evident at a glance, and is peculiar to the Swedish Mauser models. M94/M96 receiver bridges are slotted to provide clearance for the guide rib on the M94/M96 type bolt body. This feature originated on the Swedish M94 and was used later in the M98 design. The M94/M96 type bolt body is slightly longer than M91, M92, and the M93/M95, and was manufactured with top and bottom gas vent ports. The Swedish M94/M96 firing pin is correspondingly longer to function with the longer bolt. In my opinion, the Swedish Mauser action is the best manufactured and heat treated of all the early (non-M98) small ring Mauser actions.

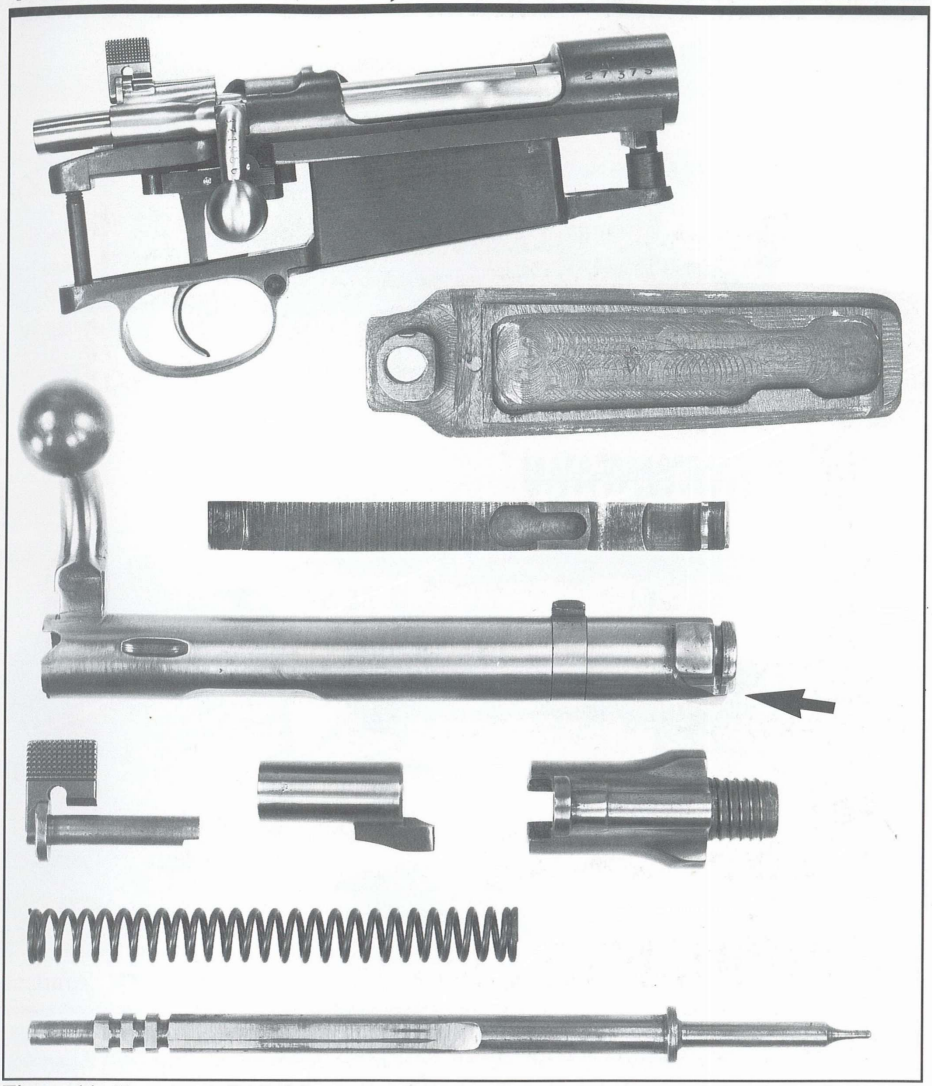


Figure 11- Shows an M93/M95 type Spanish Mauser action, at top. An M93 short rifle hinged, button release floorplate is installed on the receiver. The M93 Spanish was the first production Mauser rifle to have a staggered, five round, double row magazine with detachable floorplate. An M93 floorplate is shown, just below. The M93 action, detachable floorplate, and disassembled M93 bolt, shown at bottom, identify major M93/M95 Spanish action features.

Note: the square bottom bolt, see arrow at bolt face, originated on the M93 model. This feature was found to be unnecessary and was discontinued. However, M93 Spanish bolts, receivers, and other parts were manufactured well ahead of rifle assembly. For this reason, M95 actions are often found with receivers milled to receive square bottom bolts.

The M93 Spanish was the first mass produced Mauser model to use the keyed lug, quick assembly firing pin and cocking piece that became standard in later Mauser actions. Other M93 updates, which actually originated on the model of 1892, include the nonrotating claw extractor and the trigger/sear/bolt safety interlock mechanism shown in figures 13 and 14. The success of the M1893 established the pattern that lead to the development of the M94/M96 Swedish and M98 actions.

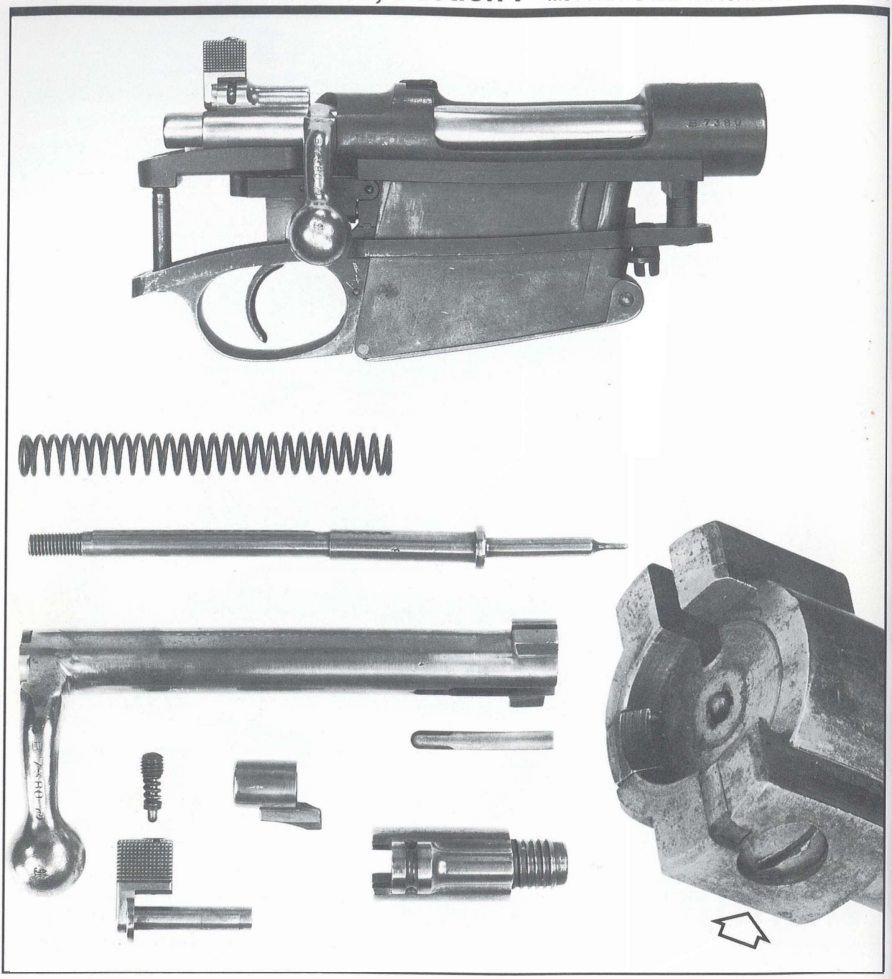
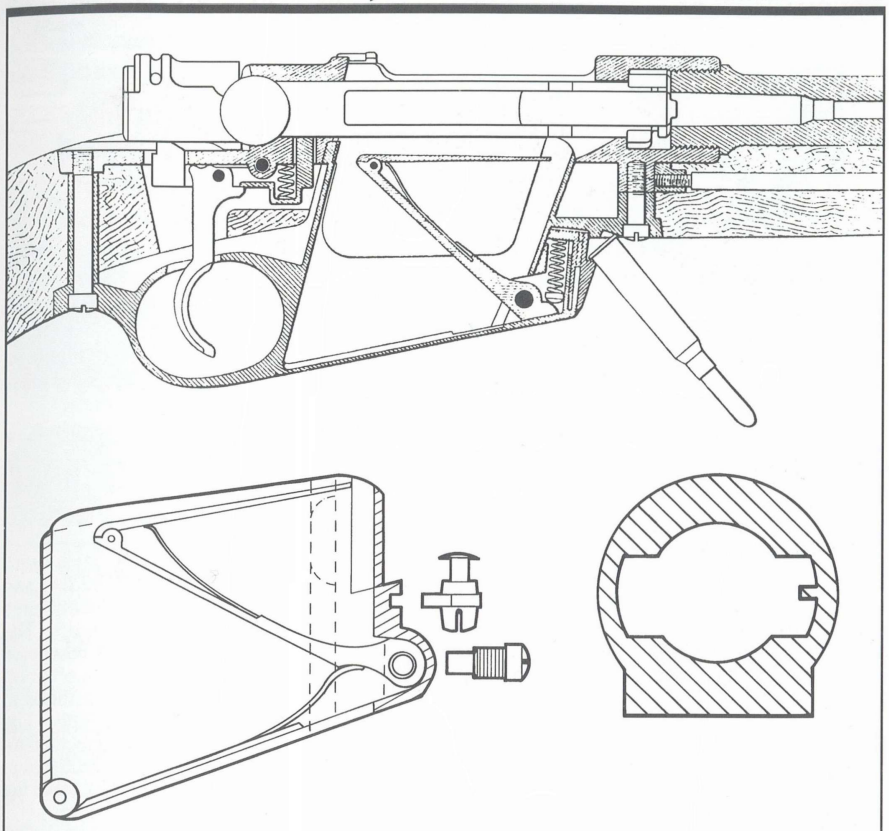


Figure 12- Shows an M91 Argentine Mauser action, at top. The M91 and M92 Mausers retained early style single row magazines. See half sectional illustrations on page 22. The M91 Argentine action above, and disassembled M91 Argentine bolt, shown at bottom, identify major M91 action features. The M91 was the last Mauser action to use the old style, small claw extractor that rotated with the bolt. Spanish contract type M91 actions were basically the same as the Argentine, but had somewhat different bolts (see close view of M91 Spanish bolt face, at left). The M91 Spanish had an additional plunger, spring, and screw installed in the right locking lug, see arrow, and a slot milled under the lug to pick up the cartridge rim. This modification was intended to improve extraction and prevent double loading. To improve extraction and offset the somewhat weakening effect of this modification, extractors in Spanish contract M91 bolts were repositioned as shown above and in figure 25. M91 actions have longer front rings than later pre-M98 small ring actions. Due to the excellent steels used in manufacturing and a greater receiver/barrel thread count (typically seven full threads) the M91's are somewhat stronger than the M93/M95 Spanish Mauser actions. However, being closer in evolution to the black powder cartridge Mauser actions, M91's do not have bolt or receiver gas venting ports and do not channel vented gasses well.



Drawings not to scale. M92 action redrawn from the original principal illustration drawing by VSP staff artist.

Figure 13- Half sectional M92 illustration, at top, identifies M92 Mauser action features. A half sectional view of an M91 detachable box magazine is shown below for comparison. The M92 was purely a transitional model, and is shown here for reference because of its important features that were incorporated into later Mauser actions. The M92 and M92/M93 and the various experimental rifles that were based on these transitional models were manufactured in very small quantities. Probably most of the specimens that have survived are in the hands of collectors or museums.

Major M92 improvements over the M91 model included a new style non-rotating, spring claw extractor with rotating retaining collar; a trigger/sear/bolt mechanical safety interlock system (to prevent sear release until the bolt is locked- also see figure 14); and an updated integral, straight line magazine with removable floorplate assembly. The longitudinal receiver bolt guide rib, shown in the cross section below, originated with this model and was used in the later M93/M95 Spanish Mauser design.

The M91 style threaded firing pin and cocking piece; safety lever assembly retained by a separate plunger, spring, and screw; and single row magazine were carried forward in the M92. The seldom seen 92/93 Model was almost an M93.

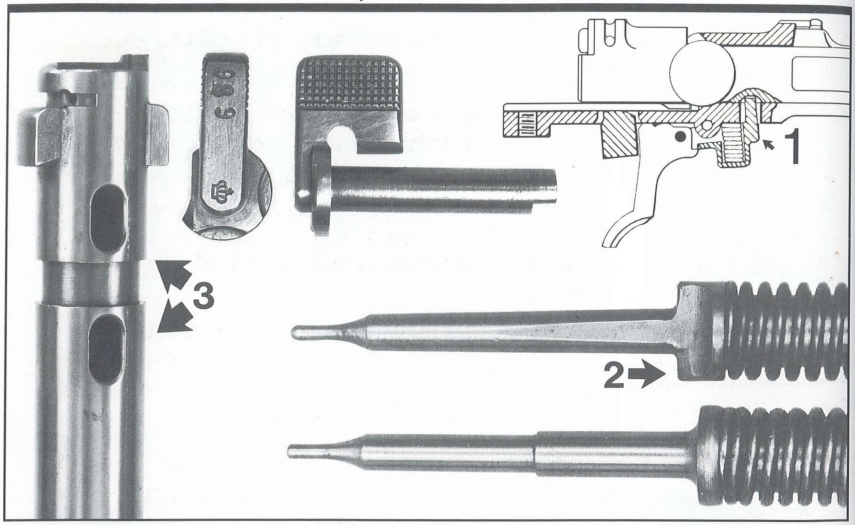


Figure 14- Shows basic Mauser safety features. Bolt sleeve mounted firing pin safety levers with safe, disassembly, and fire detents similar to the M96 lever, above, were standard in military and commercial Mauser action production, beginning with the M93. M91/M92 levers do not have a disassembly detent. Some sporting rifles were made with nonmilitary triggers and safeties. The trigger/sear/bolt safety interlock mechanism, at **#1**, was introduced in 1892 and was used throughout Mauser M92~M96 rifle and carbine production. This mechanism consists of a bolt interlock stud at the front of the sear housing that extends vertically through a port machined in the receiver and indexes with a narrow clearance slot milled into the bottom of the bolt body. The bolt interlock stud prevents the trigger from moving the sear and releasing the firing mechanism until the bolt is rotated to the closed position. When the interlock clearance slot is directly over the stud, the trigger can then cam the stud upward into the slot to lower the sear and release the firing pin. The more positive M98 internal firing pin safety design replaced this system.

M91~M96 firing pins retract and quarter cock with 90° upward rotation of the bolt. The cocking piece engages a notch in the bolt body when the bolt is in this position. This notch maintains quarter cock as the bolt is drawn back and returned forward. Full cock is accomplished by pushing the bolt forward and locking it. The two normal conditions under which the firing pin will disengage from the quarter cock notch and return to the forward uncocked position are: when the bolt is rotated up and then down without drawing it back; and when the bolt is drawn back and returned forward and the trigger is manipulated to permit the cocking piece ledge to bypass the sear, and the bolt is then closed. This function permits decompression of the firing pin spring for rifle storage. **Warning**: If a loaded round was chambered before or during this manipulation, the cartridge would fire, in most cases, as the extended firing pin was forced forward into the primer.

The M98 action full-cocks the firing pin mechanism with 90° upward rotation of the bolt. The bolt's cocking surface cams the cocking piece extension back about 3/8" to do this. The full cock shoulder on the rear of the bolt body is then rotated into position to secure full cock engagement. The sear engagement ledge, located further back on the cocking piece, then engages the sear just as the bolt is closed. This further compresses the firing pin spring approx. 1/16" to 1/8". The M98 firing pin decocks by holding the trigger back and closing the bolt. The bolt decock/chambered round warning given above applies to M98 actions, as well. M98 firing pin safety lug shoulders, shown at **#2**, are designed to stop firing pin travel if the firing mechanism is released, for any reason, before the bolt is fully locked. M98 bolt bodies and firing pins must be in serviceable condition for this system to work. Inspection and function checking of this safety mechanism is too often ignored. See page 45 for checkout data. Some early Oberndorf commercial M98 sporter actions did not have this feature. See early M98 sporter firing pin at bottom. Although non-mechanical, the gas venting ports, at **#3**, function as a standby safety system in the event of case rupture or head separation, etc.

A Gunsmith's Safety Rules- or how to stay out of trouble, and possibly out of court, at the same time.

1. **DON'T work on any firearm with a safety part removed- unless the work includes reinstallation of the safety.**
2. **NEVER remove a firing pin safety from a Mauser bolt action rifle- unless the work includes replacement with a high quality custom trigger with a sear block type safety mechanism and correct adjustment of the trigger and safety, thereafter.**
3. **WHEN working on Mauser type actions- make 100% sure that the cocking piece and sear are correct, in serviceable condition, and that the safety lever and cocking piece interact correctly and safely.**
4. **FOR your protection- always keep records of work done.**
5. **IF you begin work on a firearm that you determine is not reliably repairable or inspect a firearm you determine is not in good working order- always write a shop ticket, and: "WARNING- NOT SAFE TO FIRE" on the ticket.**
6. **DON'T do patch-job repairs- do it right or skip it.**
7. **DON'T work for those who insist on substandard work.**
8. **NEVER hand (or take) any firearm unless you have personally checked its magazine and chamber.**
9. **NEVER trust anybody- GUNS ARE ALWAYS LOADED!**
10. **NEVER point any firearm- except at a target.**
11. **NEVER believe what anyone says about the condition of any firearm- always fully inspect it yourself.**
12. **ALWAYS cast and measure unknown chambers and bores.**
13. **ALWAYS gauge check headspace and advise the customer.**
14. **NEVER forget to check for barrel obstructions or bulges. Just do it- it's only common sense.**
15. **WEAR safety glasses and ear protection when needed.**
16. **HEED cautions when using solvents or chemicals.**
17. **DON'T permit live ammunition in the work area.**
18. **FOLLOW these safety rules- after all, the life you save could be your own.**
19. **THINK it through first- you'll always save time later.**

If you violate these simple rules- you will, sooner or later, pay the price for it.

Additional Industry Shop Safety Warnings-

The following supplemental industry safety warnings and cautions are suggested for riflesmiths and general gunsmiths. These warnings actually apply to all who handle and/or work with firearms:

1. Before handling, inspecting, disassembling, or cleaning, always ensure that the rifle is not loaded- so that the rifle will not fire. (**Note**: also see safety warnings in figures 14 and 15.)

2. Do not permit live ammunition at the bench or in the shop work area.

3. Safety glasses should be worn at the bench at all times. This is particularly important in the event you lose control of a spring, plunger, or other spring loaded component which could cause injury.

4. Safety glasses should be worn in the shop at all times- to protect against flying particles. This is particularly necessary when operating, or working near, sanders, grinders, and cutting machines. Shop injuries can result from careless work habits. Examples include: failing to properly secure work in machines before operation (flying fragments from broken cutting tools and/or parts thrown); attempting to hand stop drill press chucks (sharp edges and burrs can cut or gouge hands), and failure to remove lathe and drill press chuck keys before startup (thrown chuck keys can cause serious eye and bodily injury).

5. Always take precautions when handling or using solvents, cleaning fluids, lubricants, or any chemicals. Consult manufacturers instructions before use. Make it a practice to wear protective clothing; a rubber apron and gloves, a face shield, etc., when using chemicals and solvents. Splattered chemicals, particularly hot bluing salts, can cause permanent injury.

6. Always wear eye and ear protection when shooting/test firing- to reduce the risk of cumulative, long term hearing loss and/or eye injury.

7. Take precautions to avoid contamination- by accumulations of solvent fumes and/or chemical vapors. Take similar precautions against toxic gas fumes and/or lead dust where firearms are tested indoors or within a confined space such as an indoor range.

It is also suggested that riflesmiths, general gunsmiths, and all others who own, use, or handle firearms fully familiarize themselves with action function and safety system operation of the specific models being handled before loading or test firing.

Before Disassembly

Before disassembling any Mauser M91 through M98 rifle or action for repair, the experienced riflesmith always takes the necessary few minutes to precheck function. In this way, he can easily gain an overall idea of what might be right or wrong with a particular action, and any work that might be needed. A detailed precheck list, such as the one given below, can help the riflesmith focus on an action area, or part, that might be worn or damaged and that could cause a possible problem. A few minutes taken in the beginning always saves time later.

Always begin by placing the firing pin safety lever in disassembly position; removing the bolt; and visually checking to make sure the magazine and chamber are unloaded.

Before Disassembly Precheck List:

1. Inspect bolt face condition- pitted? primer leak erosion? smooth? OK?
2. Inspect firing pin port in bolt face- rusted? oversize? size OK?
3. Check extractor- correct for model? condition OK?
4. Inspect bolt locking lugs- pitted? worn? altered? apparently OK?
5. Check cocking piece/sear engagement surfaces- worn? altered? OK?
6. Inspect bolt assembly overall exterior condition- worn? pitted? OK?
7. Check ejector box / bolt stop-spring tension OK? stop surface OK? pivot screw OK?
8. Check ejector arm- correct for model/caliber? damaged? OK?
9. Inspect bore- obstructed? bulged? scored? visible wear? rusty? OK?
10. Inspect chamber- dirty? rusty? pitted? clean and shiny? OK?
11. Inspect muzzle crown- nicked? dented? correctly recrowned? OK?
12. Visually check receiver exterior- pitted? damaged? altered? OK?
13. Check receiver interior- cocking piece slot, bolt lug ways and cartridge ramp OK?
14. Check magazine rails and follower- OK? magazine spring OK?
15. Install and slowly cycle bolt- bolt or extractor drags? smooth? OK?
16. Close bolt, engage firing pin safety- stops? stiff? engages smoothly? OK?
17. Pull trigger with firing pin safety engaged- safety holds OK?
18. Repeat #17, and turn firing pin safety to "fire"- action fires? holds cock? OK?
19. Check trigger pull- stiff? soft? OK?
20. Rap cocked action sharply (safety off)- sear impacts off? sear holds? OK?
21. Inspect firing pin tip- condition and protrusion OK?
22. Check headspace- bolt must close on "go" gauge but not on a "no-go" OK?
23. Load dummy rounds and check feed- pickup rough? smooth? OK?
24. Check trigger guard/receiver fit- bent? offset? fits tight? fits OK?
25. Check trigger fit inside guard- binds/drags trigger guard? moves freely? OK?
26. Check barrel fit in receiver- loose? tight? sights at 12:00 o'clock? OK?
27. Check sights- modified? loose? screws/pins OK?
28. Note general appearance- worn? scratched? dents? rusty? or as new?

Likely as not, it will take you the better part of a half hour the first time you go through the above list seriously with an M91~M98 Mauser rifle action in hand- but make it a habit, anyway. Make prechecking and rechecking second nature, just like it is with all experienced gunsmiths. Later on, you'll do it in minutes.

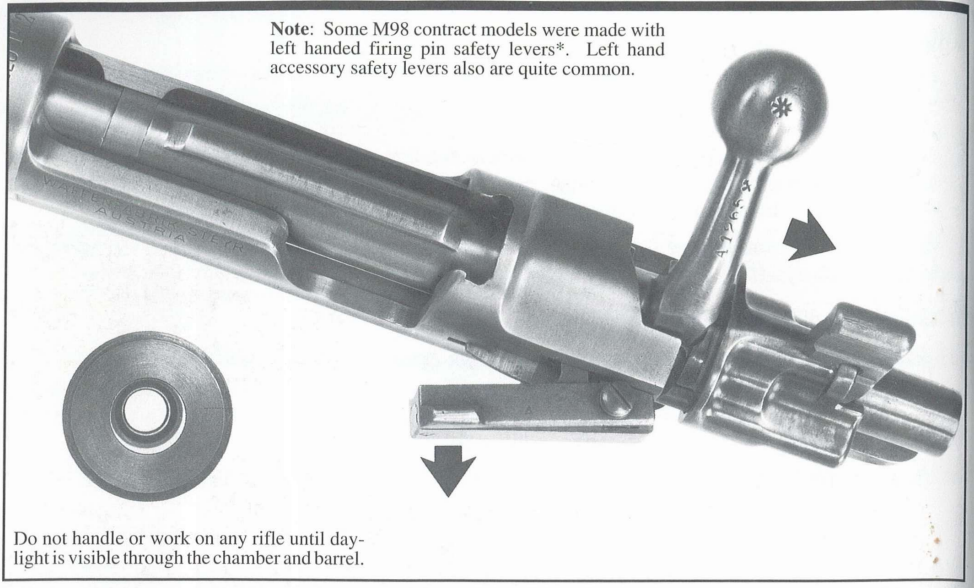


Figure 15- Shows the bolt being removed from an M98 action. Until unloaded magazine/chamber status has been verified, the "**all guns are loaded**" rule always applies. The firing mechanism must not be decocked, the trigger manipulated, or the safety system checked until it has been positively determined that the magazine and chamber are both unloaded. Even if the magazine is empty, always visually check the chamber. Don't work on any bolt action rifle unless daylight is visible through the barrel and chamber. See figure 14 for Mauser safety system and bolt cocking/decocking data.

M98 actions cock with upward 90° rotation of the bolt handle. The firing pin safety lever* can't be moved to the disassembly or safety position unless the firing mechanism has been cocked. Stated another way, **if the safety lever is already on, the action is cocked**. However, in a serviceable action, the bolt can't be opened with the firing pin safety lever in the safe position. **Warning**: before moving the safety lever from the safe position to either the disassembly or fire position, always point the muzzle in a safe direction to prevent mishap in the possible event that the rifle might be loaded and a safety system malfunction might occur. Always place the firing pin safety lever in the straight up disassembly position when removing a loaded round from a chamber. Once unloaded status has been verified, the firing pin safety lever can be left in the fire position, if desired, for simple bolt removal.

M93 through M96 firing mechanisms are also set up for bolt removal or disassembly by placing firing pin safety levers in the disassembly position. See decock warning in figure 14.

M91and M92 firing pin safety levers, unfortunately, do not have a disassembly detent . These firing mechanisms secure the bolt assembly in the locked position until the safety lever has been turned all the way to the fire position. Cocked M91/M92 unloaded chamber status can only be checked by holding the muzzle in a safe direction, placing the safety lever in the fire position, and opening the bolt. Unloaded magazine status is easily determined by removing the M91 magazine or M92 floorplate assembly. The screw on type cocking pieces used in M91 and M92 bolts require a special disassembly procedure. See page 31.

With unloaded status confirmed, M91 through M98 bolts can be removed by pulling out the ejector box until the bolt stop clears the bolt body and then withdrawing the bolt assembly from the receiver.

*The term firing pin safety lever is used to identify the bolt sleeve mounted, standard military type safety, shown above, and to distinguish this mechanism from other commercial and/or accessory safety mechanisms that, instead, block the trigger or sear.

Warning: Many military surplus bolt action rifles have mixed bolts (serial numbers are different). Bolt exchanges are sometimes the result of arsenal rebuilding or rebarrelling, but are also often done by exporters and importers. The bolt assembly in any given Mauser rifle could be from an entirely different lot or rifle contract. Bolt exchanges always affect headspace. Regardless of apparent originality or condition, always check headspace before firing.

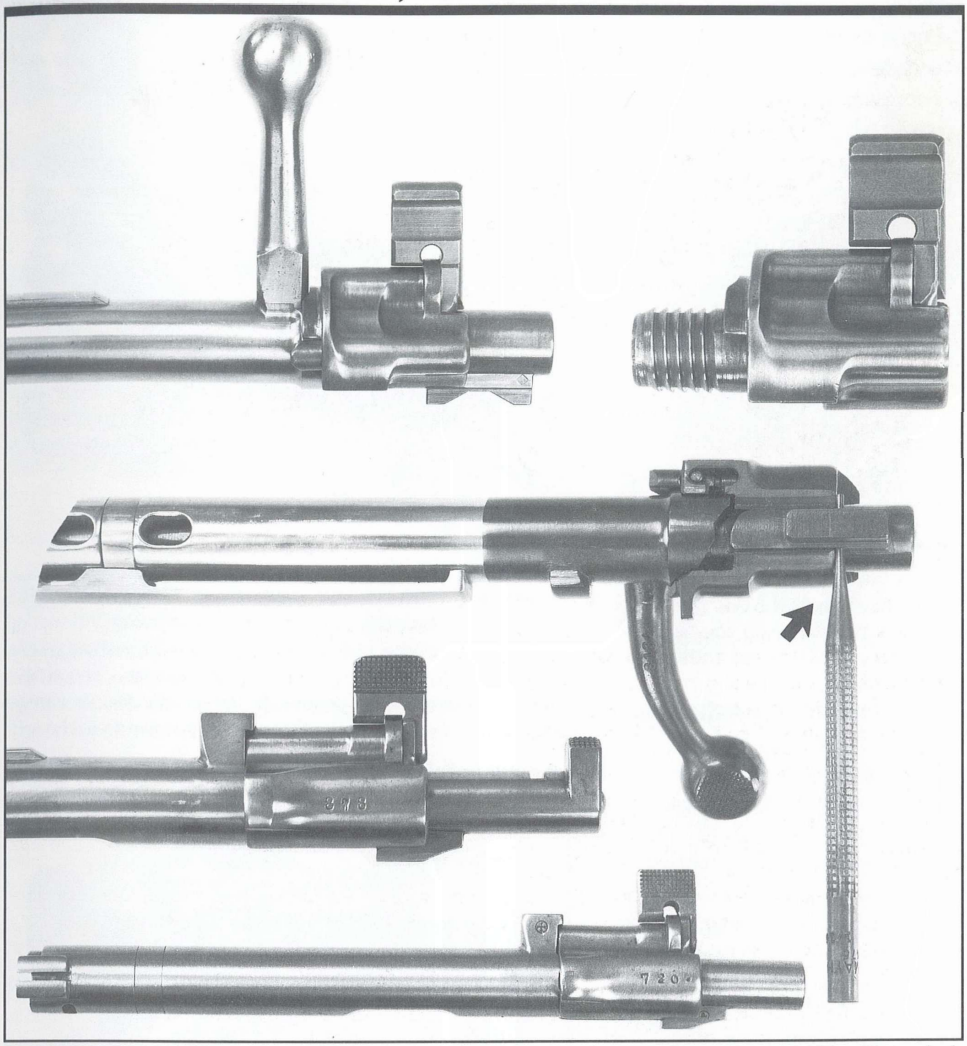


Figure 16- Shows Mauser bolt assemblies set up for firing mechanism removal. An M98 military bolt with standard military type bolt sleeve and firing pin safety lever is shown at top. These firing mechanisms are easily removed by first placing the firing pin safety lever in the disassembly detent, pushing in on the bolt sleeve lock plunger, and unthreading the bolt sleeve as discussed on page 30.

A commercial M98 sporter bolt assembly with streamlined bolt sleeve is shown in second position. Most trigger mechanisms in sporter actions of this type have side mounted safety levers. Sporter bolts of this type are set up for disassembly by first drawing the cocking piece back and inserting a 1/16" punch through the cocking piece disassembly hole, as shown at arrow, above.

These preparatory setups retain the cocking piece and hold it well to the rear and clear of the bolt body. Secured in this position, the retained firing pin mechanism/bolt sleeve assembly can be easily unthreaded from the bolt body as discussed in figures 17 and 18. Once removed, the firing mechanism and bolt body can be routinely cleaned, or further disassembled for a detailed parts cleaning and inspection. Earlier style M91/M92 bolts set up for disassembly and takedown differently. See pages 31 and 34.

Mauser M94/M96 Swedish and M93/M95 Spanish bolts are shown at bottom. Firing mechanisms in these bolts are removed by turning the bolt sleeve to the left to unthread it from the bolt body.

Remove M98 Standard Firing Mechanism (Military Type)

Before manipulating the bolt, safety lever, or trigger, see loaded round, cocked bolt, and decocking safety warnings in figures 14 and 15.

1. Cock the bolt by rotating the bolt handle upward 90°. Then return the bolt to the closed position.
2. Place the firing pin safety lever in the vertical (12:00) bolt disassembly position.
3. Pull back the bolt stop and draw the bolt assembly out of the receiver. See figure 15.
4. Depress the lock plunger in the bolt sleeve to release the sleeve.
5. Then, rotate the bolt sleeve to the left (as viewed from the rear of the bolt sleeve) and unscrew the firing pin assembly from the bolt body. See figure 17.

M98 Commercial Bolt Sleeves Without Safety Levers-

1. Cock the bolt, as above.
2. Pull back and retain the cocking piece by inserting a 1/16" punch into the exposed disassembly hole in the cocking piece . See figure 16.
3. Pull back the bolt stop and remove the bolt assembly from the receiver.
4. Depress the lock plunger at the front of the bolt sleeve.
5. Turn the bolt sleeve to the left (as viewed from the rear of the sleeve) and unscrew the firing pin assembly from the bolt body. See figure 17.

Remove M93 through M96 Firing Mechanisms

1. First cock the bolt by drawing it back and then closing and locking it.
2. Place the firing pin safety lever in the vertical disassembly position.
3. Pull back the bolt stop and remove the bolt assembly from the receiver.
4. Then, unscrew the firing pin assembly by turning the bolt sleeve to the left, as viewed from the rear of the bolt sleeve. See figure 18.

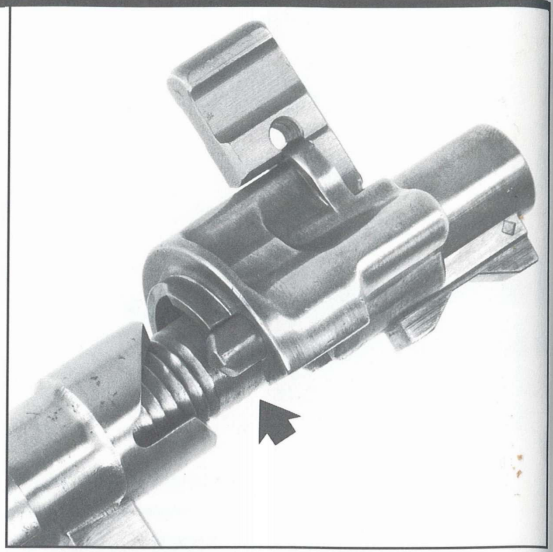


Figure 17- Shows a close view of a standard military M98 type bolt sleeve and firing pin mechanism being unthreaded from the bolt body. All but the earliest M98's were manufactured with sleeve lock plungers as shown. The sleeve lock plunger must be pushed in before the sleeve can be turned. The bolt sleeve is unthreaded by turning to the left.

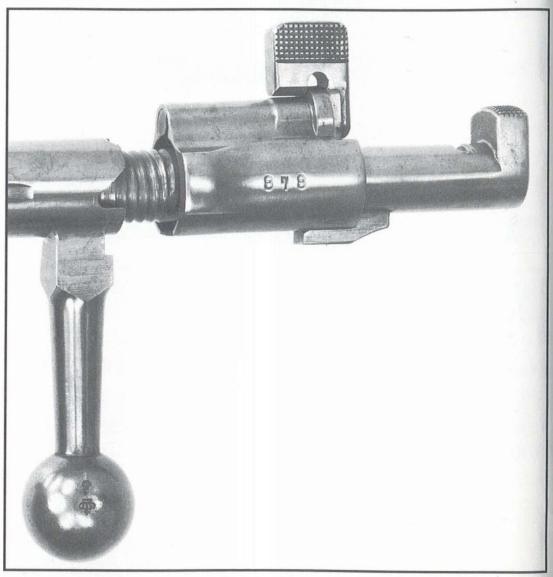


Figure 18- Shows an M94/M96 type bolt sleeve and firing mechanism being unthreaded from the bolt body. M93/M95 bolt sleeves and firing mechanisms are basically similar, except for the short, straight cocking piece. M93~M96 models did not have bolt sleeve locks, which accounts for the dents often found in the slot at the end of the receiver tang.

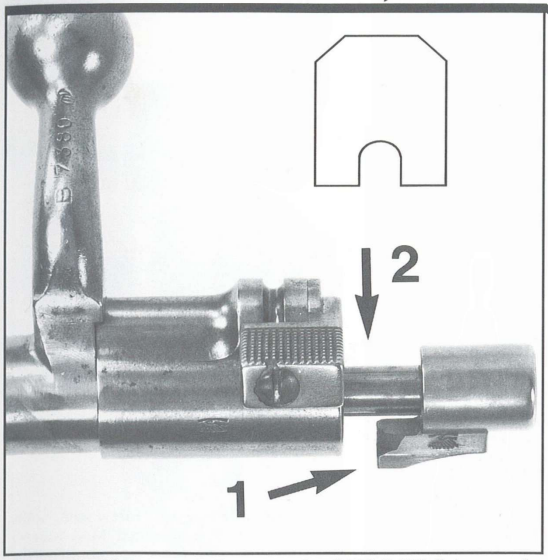


Figure 19- Shows steps for removing M91/M92 firing mechanisms. The cocking piece sear engagement ledge, at **1**, is drawn back against a brass bar secured in a bench vise. An 1/8" insert, illustrated above, is placed between the cocking piece and bolt sleeve, at **2**. This holds the cocking piece away from the bolt and allows the bolt sleeve to be unthreaded.

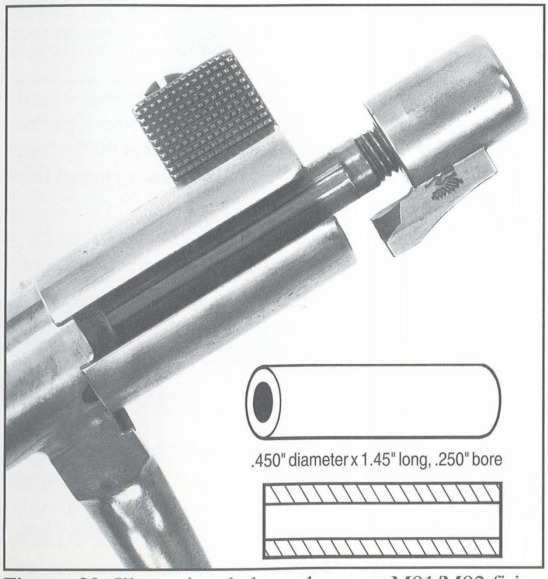


Figure 20- Illustration, below, shows an M91/M92 firing pin spring compressor tool used to disassemble M91 and M92 firing mechanisms and bolts. After tool installation, the firing mechanism is then screwed back into the bolt until the cocking piece extension clears the bolt sleeve. Once clear, the cocking piece can be unthreaded from the firing pin.

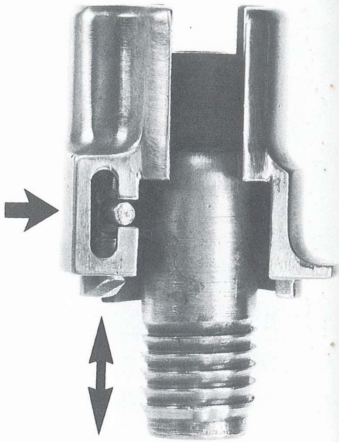
Remove M91/M92 Type Firing Mechanisms

The Mauser interrupted lug (key-slot engaged) cocking piece/firing pin system was patented in 1893, and first appeared in Spanish contract M92/93 and M93 rifles.

The M91's and M92's were the last of the Mauser bolt actions to use the threaded firing pin-cocking piece design that had been carried forward from the previous black powder models. Shop disassembly of these firing mechanisms can be difficult without a spring compressor. This tool unsprings and frees the cocking piece so that it can be unthreaded for bolt takedown. A spring compressor tool is easily made by turning a piece of round brass stock to .450" dia., trimming to 1.45" long and drilling a .250" hole through the axis. See figure 20.

1. Install a piece of flat brass bar stock in a bench vise. Make sure the bar engagement edge is square so the cocking piece will not slip off.
2. Hold the cocking piece firmly against the brass bar and draw the cocking piece back approx. 3/16".
3. Install an 1/8" aluminum insert between the front edge of the cocking piece and the back of the bolt sleeve to retain the cocking piece.
4. Relax pressure on the bolt body to ease the cocking piece onto the insert. This holds the forward part of the cocking piece clear of the bolt body so that the bolt sleeve can be unthreaded.
5. Unscrew the bolt sleeve and retained firing pin assembly from the bolt body. The firing mechanism may not need to be disassembled beyond this point, unless the assembly is to be taken down further for detailed cleaning and parts inspection. See figure 23 for disassembly of the firing mechanism and bolt.





Note: Although now very rarely seen, some early Oberndorf commercial M98 Mauser sporter actions were manufactured without the above standard M98 bolt sleeve locking plunger feature. Instead, the cocking piece forward extension was pointed and indexed with a shallow detent milled into the back of the bolt body. This style bolt body, bolt sleeve, and cocking piece must match in order for this variation to function correctly.

The disassembly block, as shown in figure 22, is suggested for M93~M98 firing mechanism disassembly. A slightly larger than firing pin diameter hole drilled into the disassembly block helps prevent bending firing pins during disassembly and reassembly.

Figure 21- Shows a standard military M98 firing mechanism after unthreading and removal from the bolt body. Cocking pieces in commercial M98 sporting actions that do not have the military type firing pin safety lever, shown above, are prepared for takedown as shown in figure 16. Except for the thumb hold position, discussed in **#2 below,** disassembly steps for M98 military and sporting model firing mechanisms are as shown above and listed below.

1. Place the firing pin tip in a wood or aluminum disassembly block, as illustrated in figure 22. A slightly oversize firing pin hole (about .100" in diameter) can help prevent bending the firing pin tip.

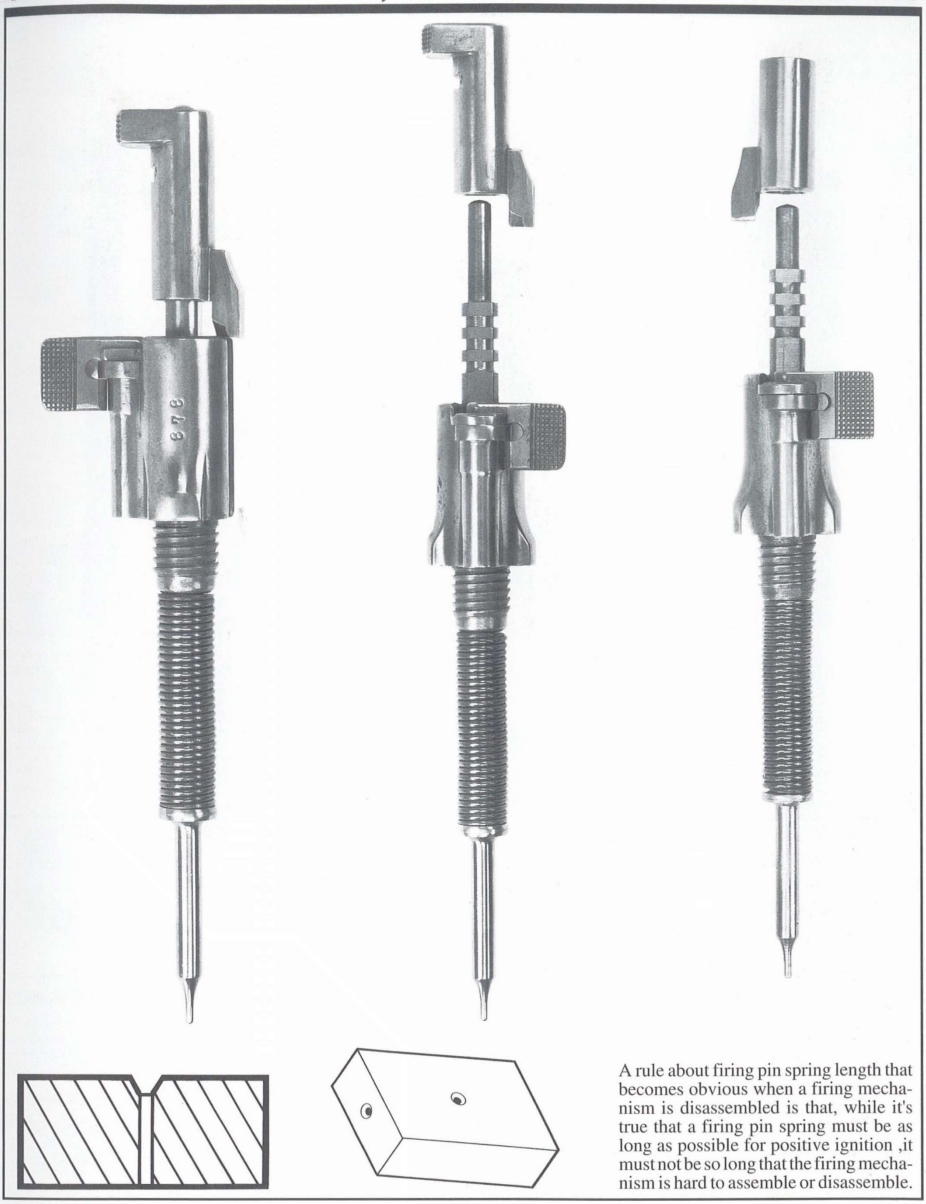
2. With the safety lever in disassembly position, grasp the bolt firmly with thumb squarely on the safety lever and push downward on the safety lever and bolt sleeve, compressing the firing pin spring, until the cocking piece forward extension just clears the back of the bolt sleeve.

3. Then, rotate the cocking piece 90° in either direction to disengage it from the firing pin/cocking piece keyslots. Pull the cocking piece upward and off the firing pin.

4. Ease the bolt sleeve upward, carefully, until the firing pin spring is fully decompressed. Then, remove the sleeve and the firing pin spring from the firing pin. **Caution**: the bolt sleeve is under strong spring pressure. Prevent possible head and/or eye injury by holding the bolt sleeve firmly during disassembly and allowing only slow upward movement until all spring tension has been relieved.

5. Remove the bolt sleeve lock plunger assembly by pushing the plunger back into the sleeve body until the plunger's travel stop stud aligns with the disassembly slot in the sleeve body. While holding this position, push the stop stud inward (toward the center of the sleeve body) until the stud is clear of the disassembly slot.

6. Then, carefully, ease the lock plunger forward until plunger spring energy is zero. Drop out the lock plunger and spring. Place all action parts in a box for later cleaning, inspection, and reassembly.



A rule about firing pin spring length that becomes obvious when a firing mechanism is disassembled is that, while it's true that a firing pin spring must be as long as possible for positive ignition ,it must not be so long that the firing mechanism is hard to assemble or disassemble.

Figure 22- Shows Mauser M94/M96 and M93/M95 firing mechanism disassembly. These firing pin mechanisms were not made with bolt sleeve lock plungers, but otherwise take down in the same way as military M98 firing mechanisms. The disassembly block, illustrated above, is used to minimize the possibility of firing pin tip damage and to keep the firing pin from slipping sideways on the bench. Both M94/M96 and M93/M95 firing mechanisms are disassembled by pushing down on the safety lever and bolt sleeve until the cocking piece extension clears the sleeve. Cocking pieces are then removed by rotating 90° in either direction and lifting up and off the firing pin. **Caution**: the bolt sleeve is under strong spring pressure. Prevent possible head and/or eye injury by holding the bolt sleeve firmly during disassembly and allowing only slow upward movement until all spring tension has been relieved.

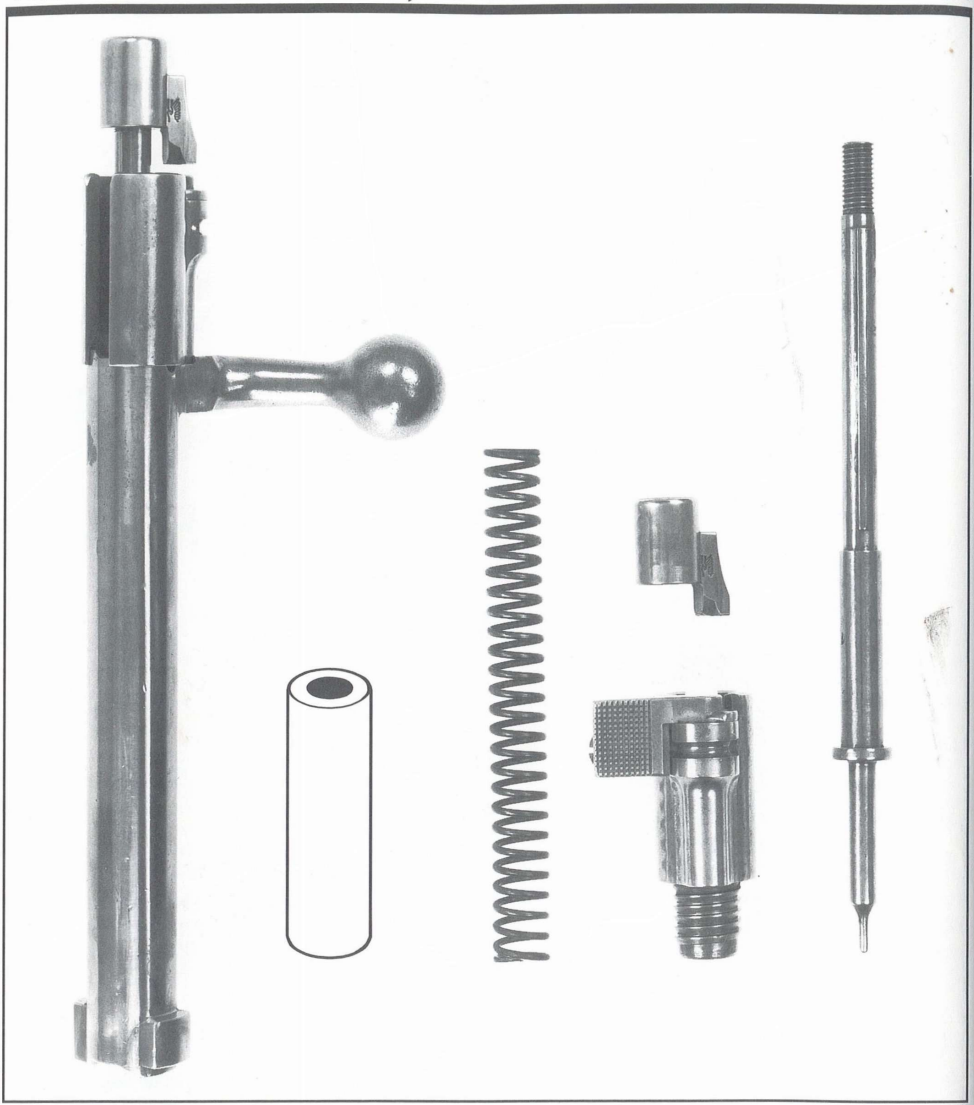


Figure 23- Shows a Mauser M91 bolt assembly, at left, with spring compressor tool installed and cocking piece set back and clear of the bolt sleeve, ready for disassembly. The spring compressor tool is illustrated above, next to the bolt assembly. Also see page 31 for correct setup for disassembly. M91/M92 type cocking pieces must be drawn back to provide bolt body clearance and retained in place before the bolt sleeve can be unthreaded to install the spring compressor tool.

1. Secure the cocking piece, as shown in figure 19, and unscrew the bolt sleeve and firing mechanism.
2. Install the firing pin spring compressor tool on the shank extension at the front of the firing pin.
3. Screw the bolt sleeve and firing mechanism back into the bolt until the cocking piece extension is well clear of the back of the bolt sleeve.
4. Then, unthread the cocking piece.
5. Unscrew the bolt sleeve slowly to de-tension the firing pin spring. See caution in figure 22.
6. Remove the firing pin spring, firing pin, and spring compressor from the bolt body.



Figure 24- Shows Mauser M98, M94/M96, and M93/M95 extractors set up for removal. Mauser nonrotating claw type extractors are mechanically retained on the bolt body by engagement of the extractor ring keys inside the keyway slots milled into the underside of the extractor. See extractor ring and key slot illustration, at top.

A. M98 Extractors- Apply thumb pressure at the side of the extractor at the extractor ring junction. Push evenly until the extractor guide has rotated past the end of the guide slot and up onto the curve of the bolt body. Continue until extractor position is about midway between the bolt lugs, as shown above. If the extractor is too tight to rotate by hand, use extractor pliers as shown at top. Then, push the extractor straight forward and off the extractor ring key and bolt body.

B. M94/M96 Swedish Extractors- Push the extractor until the guide has rotated past the stop as with M98 models. Move the extractor until the tail rests on the flat clearance recess in the bolt body, as shown above. Then push the extractor forward to separate it from the extractor ring key and bolt body.

C. M93 Spanish Extractors- Square bottom bolt type extractors are rotated in the opposite direction (counterclockwise viewing the front of the bolt) until the extractor guide lines up with the guide clearance cut at the top of the bolt body; see front view of M93 square bottom bolt at lower left. These extractors are under virtually zero pressure at this point, and usually pull or push off easily. M93~M95 round bottom bolt extractors remove in the same way as the M94/M96 Swedish type, at **B**.

Use care to prevent damage when removing tight extractors with extractor pliers. Don't over bend.

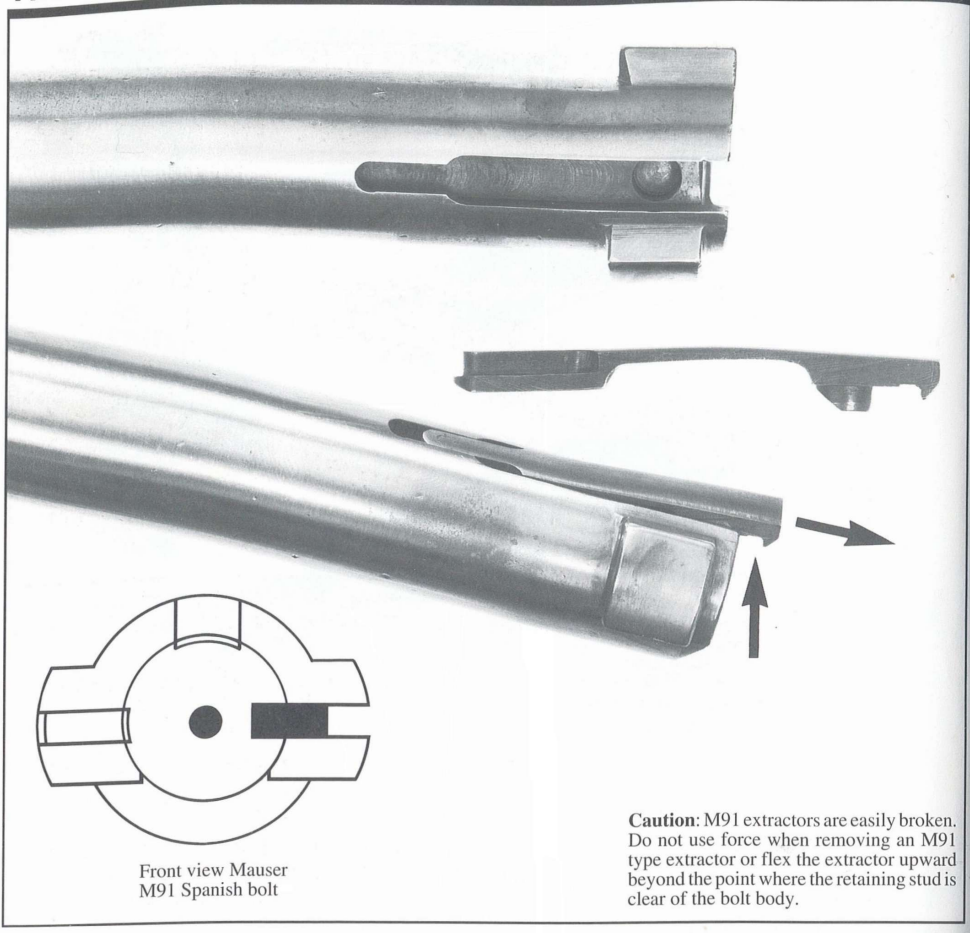


Figure 25- Shows an M91 Argentine Mauser bolt body, at top, with its rotating hook type extractor removed. A side view of an M91 hook type extractor is shown just below. The dovetailed end fits into a corresponding slot machined into the bolt body. When the extractor is pushed into the bolt body, the dovetail engagement and extractor retaining stud, see arrow, interract to retain the extractor in the bolt. Unlike Mauser's later claw extractor design, M91 extractors are captive and rotate with the bolt body as it is opened and closed.

An M91 hook extractor is shown being removed from an M91 Argentine bolt, at center. Because the M91 extractor is actually a leaf spring, it is removed by carefully flexing its thin midsection upward until the retaining stud on the underside will just clear the retaining stud recess in the bolt. The extractor is then pulled forward and out of its dovetail slot. A small screwdriver with blade end chamfered or slightly rounded is the best tool for removing M91 extractors

Caution: If an M91 extractor is resistant or stuck, soak the bolt in penetrant and rap sharply with a plastic hammer before attempting removal. M91 extractors will break if forced or excessively flexed. Do not use heat in an attempt to free a resistant extractor.

The cartridge rim plunger used in M91 Spanish contract rifle and carbine bolts required that the extractor hook position be changed. See illustration at bottom. M91 extractors are removed in the same way as the Argentine.

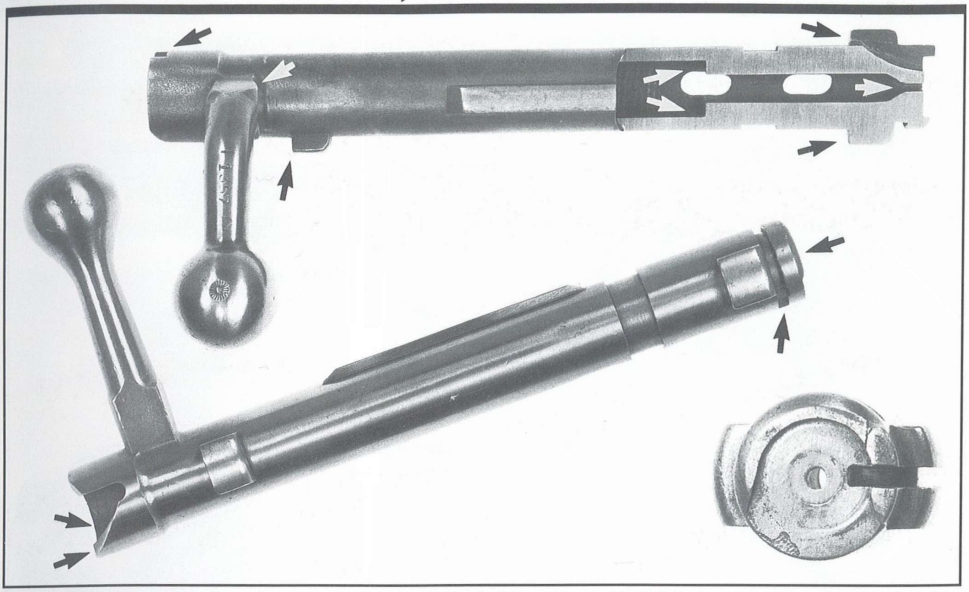


Figure 26- Shows an interior view of a partially half sectioned M98 bolt, at top, and an underside view of an uncut M98 bolt, below. Arrows indicate important detail cleaning and inspection points. Also see check list below.

1. **Firing pin safety stop shoulders**- stop shoulders and slot edges inside the bolt must not be altered, rounded off, or otherwise damaged. Replace the bolt body if the stop shoulders permit firing pin extension before the bolt is fully locked. See page 45.
2. **Firing pin spring well**- if the bolt is otherwise serviceable, light rust can be removed from the interior with a steel brush or by lightly sandblasting with fine silica sand.
   Caution: plug the firing pin port before sandblasting to prevent oversizing.
3. **Firing pin port**- must be clean and the I.D. should not be more than .002" larger than the diameter of the tip of the firing pin to be used. Bolt bodies that cannot be mated with firing pins to meet this specification should be replaced. Also see figures 30 and 58.
4. **Safety and sleeve lock plunger notch**- must be clean and unaltered.
5. **Bolt face**- suface must be level, unpitted, and at 90° to bore centerline. Bolt faces with pitting from corrosive primer leakage, as shown above, can be resurfaced on a one time basis. Not more than .010" must be removed from the face.
   Warning: headspace is increased when the bolt face is cut deeper or trued.
6. **Bolt locking lug engagement surfaces**- should show only light wear polishing. If the lug engagement ledges have been stoned, buffed, etc., headspace will be affected. If altered, pitted, or otherwise damaged, the bolt must be replaced.
7. **3rd bolt lug** (safety lug)- this backup lug must be in original factory condition. If altered, pitted or damaged, replace the bolt body.
8. **Cocking cam surface**- should show light wear polishing only. If galled, indented, altered, or damaged, replace the bolt body.
9. **Cocking piece engagement surface** (at back of bolt next to cocking ramp)- should show no more than light surface seating. This surface retains the cocked M98 firing mechanism when the bolt handle is up and/or the bolt is open. If altered or damaged, replace the bolt body.
10. **Case extracting bevel** (or extracting cam)- should show only light wear polishing. The bevel can be resurfaced if rough or worn.
11. **Extractor guide slot-** should show no more than light wear polishing. The bevelled forward edge of the guide slot (M98's only) must be intact to retain the correspondingly bevelled guide on an M98 extractor for positive case extraction. If altered or damaged, replace the bolt body.
12. **Gas vent ports**- M98 vent ports measure approx. .215" x .415". If altered, replace bolt body.

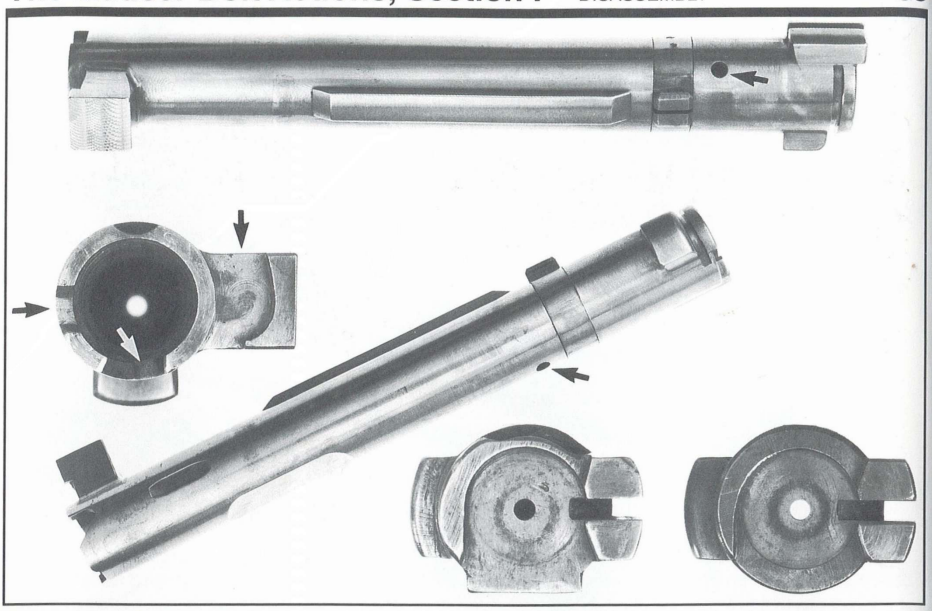


Figure 27- Shows views of a Mauser M94/M96 Swedish type bolt body. Although generally similar, M93 and M95 Spanish type bolt bodies measure about .100" shorter overall and do not interchange with other models. M93~M96 bolt cleaning and inspection points are basically the same as for the M98, shown on page 37. Differences are indicated by arrows above. See check list below.

1. **Firing pin spring well**- if the bolt is otherwise serviceable,light rust can be removed from the interior with a steel brush or by lightly sandblasting with fine silica sand.
   Caution: plug the firing pin port before sandblasting to prevent oversizing.
2. **Firing pin port**- must be clean and the I.D. should not be more than .002" larger than the diameter of the tip of the firing pin to be used. Bolt bodies that cannot be mated with firing pins to meet this specification should be replaced. Also see figures 30 and 58.
3. **Safety locking notch**- the safety notch must be clean and unaltered.
4. **Bolt face**- surface must be level, unpitted, and at 90° to bore centerline. Bolt faces with pitting from corrosive primer leakage, as shown above, can be resurfaced on a one time basis. Do not remove more than .010" from the bolt face.
   Warning: headspace is increased when the bolt face is cut deeper or trued.
5. **Bolt locking lug engagement surfaces**- should show only light wear polishing. If the lug engagement ledges have been stoned, buffed, etc., headspace will be affected. If altered, pitted, or otherwise damaged, the bolt must be replaced.
6. **Bolt rotation stop-** the stop recess must be clean and must not drag on or bind the bolt sleeve. If altered or damaged, replace the bolt body.
7. **Quarter cock bevel** (or cam)**-** should show light wear polishing only. If altered, chipped, dented, galled, or otherwise damaged, replace the bolt body.
8. **Quarter cock engagement notch**- should show no more than light surface wear polishing. This notch retains M94/M96 and M93/M95 cocking pieces in the 1/4 cock position when the bolt is open or being cycled. If an M93~M96 bolt will not hold 1/4 cock (and the cocking piece is serviceable) replace the bolt body.
9. **Case extracting bevel** (or extracting cam)- should show only light wear polishing. The bevel can be resurfaced if rough or worn.
10. **Extractor guide slot**- should show no more than light wear polishing. If the slot is altered, pitted, or damaged, replace the bolt body.
11. **Gas vent ports**- M94/M96 bolts typically have two approx. .110" dia. gas vent ports. M93/M95 type bolts usually have a single, approx. .130" dia. port, or an elongated approx. .135" x .235" port that aligns with the left receiver lug guide way. If altered, replace the bolt body.
12. **Trigger/sear/bolt safety clearance slot**- must be clean and must not be nicked, damaged, or altered from original factory dimensions.

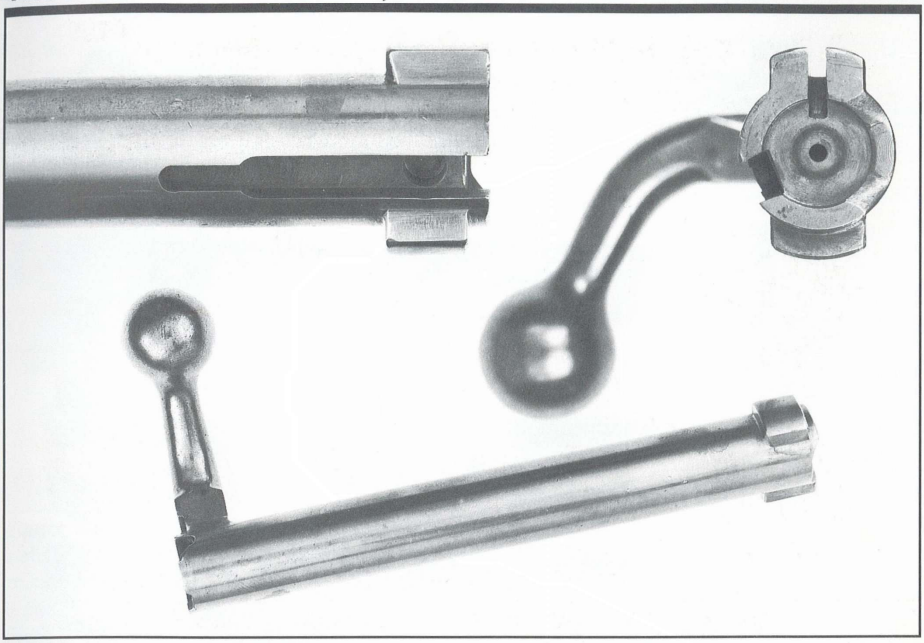


Figure 28- Shows a close side view, at top, of an M91 Argentine Mauser bolt body and extractor dovetail slot, after the extractor has been removed. A front view of an M91 bolt face and extractor slot is shown at upper right. Extractors in M91 Spanish contract type bolts were repositioned, as discussed earlier. With the exception of the extractor slot (and the plunger slot in M91 Spanish bolts), cleaning and inspection points are the same as for M93~M98 bolt bodies discussed on pages 37 and 38.

Dried lubricants and dirt tend to accumulate in the dovetail slot and in the recess under M91 extractors. Past a point, this buildup hardens and restricts full extractor hook engagement over the cartridge rim. This condition can, in turn, cause extractor slip-off and failed extraction. Dried dirt and oil buildup in M91 extractor slots can also cause the outside of the extractor to drag or hit the extractor support pin inside the receiver.

If the extractor slot is in original serviceable condition, it can be cleaned with solvent and a fine stainless steel brush. However, if the extractor slot is oversize or has been altered or damaged, or the bolt body is otherwise unserviceable, the bolt body must be replaced.

The basic quarter cock cam and engagement notch design used on the M91 bolt body, shown at bottom, was carried forward through later M92~M96 model production. Notch and cam dimensions are sometimes fractionally different in the M92~M96 models. This is probably caused by manufacturing tolerances. M91 bolts do not have the trigger/sear/bolt/safety interlock feature standard on the M93 through M96 models.

Cautionary note: M91 bolt bodies, being close in evolution to the Mauser black powder cartridge rifles, were not manufactured with gas vent ports as were the later Mauser models. The shortcoming of this is that, in the event of a possible split cartridge case, head separation, head crack, or blown primer, some amount of high pressure gas and residue would be vented backward. Shooting glasses would not provide sufficient protection in this event. This is probably the reason that M91's are sometimes found modified with .110"-.115" gas vent ports drilled into the bolt body and receiver behind the lugs in the approximate 1:30 position, as viewed from the front. Although this modification is an improvement (better than no gas porting at all), it is not a fully effective gas venting system. With this in mind, I would suggest building sporting rifles on serviceable M98 actions.

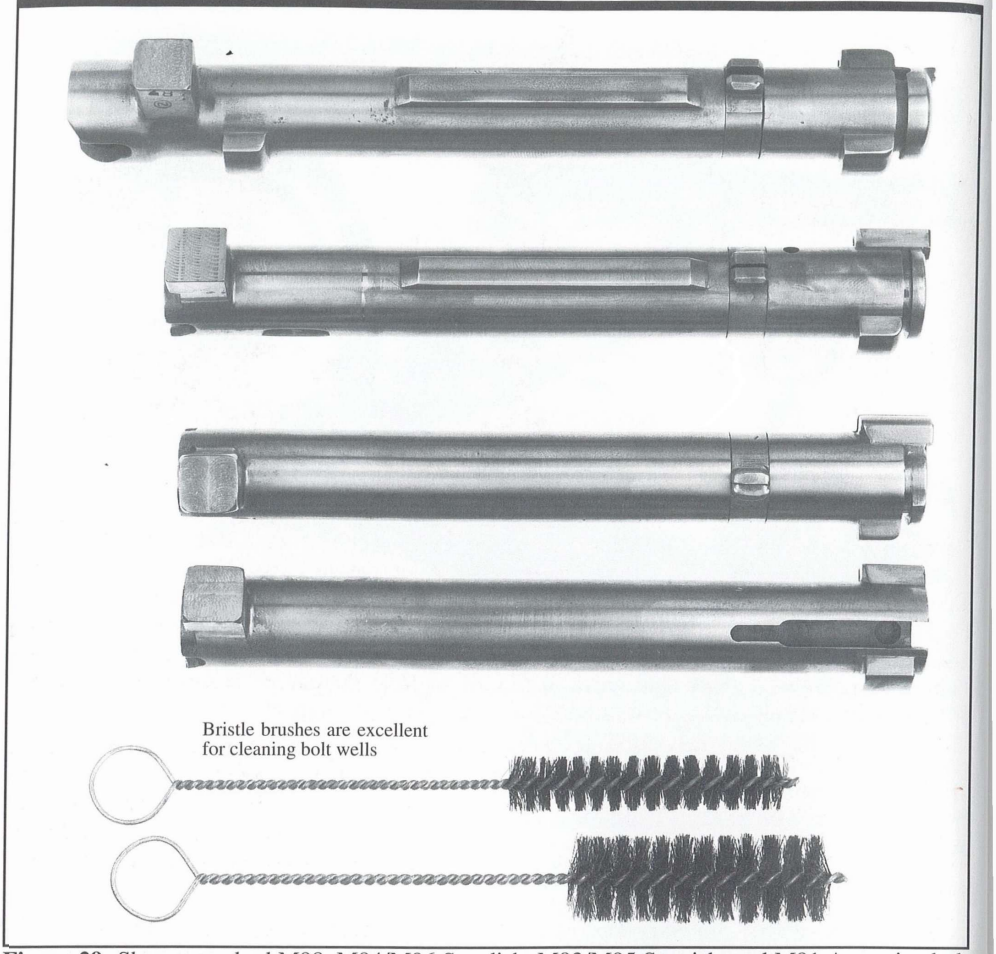


Figure 29- Shows standard M98, M94/M96 Swedish, M93/M95 Spanish, and M91 Argentine bolt bodies for comparison. Overall bolt body length is different for each model type and model variation. M98 actions and matching bolts have been manufactured in several size variations other than standard military length. Standard M98 bolt body length is approx. 6.370". Intermediate M98 bolt bodies are found in 6.165", 6.115", and 6.080" lengths. Most Oberndorf Commercial M98 short action (kurz) bolt bodies measure approx. 5.760" long. Most commercial M98 magnum bolt bodies measure about 6.770" long. Keep in mind that many M98 model variations were manufactured, and that bolts in other lengths are sometimes found. M94/M96 Swedish bolt bodies are approx. 5.630" long and M93/M95 Spanish bolt bodies are approx 5.550". See Mauser action dimension table on pages 214 and 215 for additional data.

Original bolt manufacturing tolerances, assembly fitting adjustments, and wear combine to create plus and minus variations in the above bolt lengths. Individual receiver manufacturing tolerances and wear also vary. For this important reason, bolt bodies of the same model type must not be interchanged unless they are first checked for correct fit in the matching model receiver and then successfully headspace checked. See chamber and headspace checking on pages 74 through 77. This procedure, however, does not guarantee correct lug fit. For this reason, I would recommend replacing bolts only as a part of barrel replacement, which should include lug lapping and other bolt/receiver fitting and mating steps as discussed in Section II.

When a barrel is being replaced or requalified (set back), chamber headspace is gauged and typically adjusted forward from the bolt face, with the bolt in the fully locked position as mechanical reference. When replacing a bolt only, a reverse condition exists because headspace can be adjusted only by trial and error bolt body substitution and carefully adjusting the bolt face surface when headspace is short.

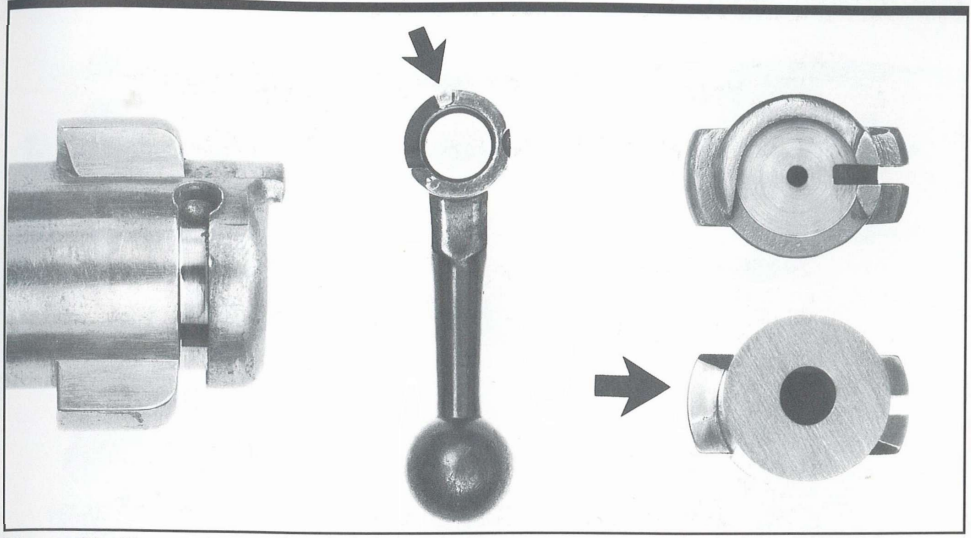


Figure 30- Shows views of operating surfaces on military M98 bolts. Mauser bolt bodies are carburized to create a thin hard exterior layer to strengthen the lugs, minimize wear, and to allow smooth bolt travel inside the receiver. In the carburizing process, surfaces absorb carbon and actually become the equivalent of high carbon steel. Having a low/medium carbon content, the remaining parent steel under the thin case layer is toughened when quenched. Low/medium carbon steel has a built in safety margin in that it is core hardenable only to a limited extent. Over carburizing can cancel out this safety factor.

The above heat treating method is commonly called case hardening. Parts heat treated in this way are wear hardened but retain a relatively soft core. This enables a bolt, for example, to withstand normal and higher operating pressures without breaking or shattering. Although purely a static reference, tensile strength of the material in an average M98 bolt heat treated in this way can exceed 100,000 lbs. yield. This, incidentally, creates a safety factor well in excess of any brass cartridge case ever manufactured.

Although there is disagreement on the subject of the useability of the Rockwell C Scale for testing case hardened low/medium steel parts, nonetheless, something can be learned from hardness testing the solid lug on Mauser bolts. C Scale readings on the M98 bolt lugs I have had tested have ranged widely from 38C to over 60C. Most lug test readings were from 50C to 55C. Suggested maximum lug hardness is 55C. Bolts that exceed this reading should be redrawn by a qualified heat treating firm or tagged as unserviceable.

In this regard, I suggest having all Mauser bolts, receivers, and cocking pieces hardness checked and reheat treated, if necessary, as a part of rebuilding actions and before barrel installation and use when restoring Mauser military rifles that are to be fired. The same would hold true when building custom sporting rifles on Mauser actions. Use only heat treating firms that are thoroughly familiar with firearms heat treating requirements and Mauser actions in particular. Hardness testing is suggested as cheap insurance because it rules out guess work and is a reliable way to eliminate a potentially dangerous hard bolt. Also see receiver hardness on pages 70 and 71.

Hardness testing requires the proper anvil to support the part being tested. Areas that are not correctly supported tend to flex or deflect thrust on test point impact and can't be reliably checked.

Bolt hardness testing is too often skipped when bolts are being replaced and actions are being rebarrelled, perhaps because overly hard bolts are very rare and too soft bolts are easily identified by the appearance of the lug engagement surfaces and/or an indented cocking piece engagement surface at the rear of the bolt body. Arrows above show thin, worn away case hardening on the Argentine M98 bolt lugs at bottom right. Also see cocking piece indentation at the rear of the soft M98 bolt, at center.

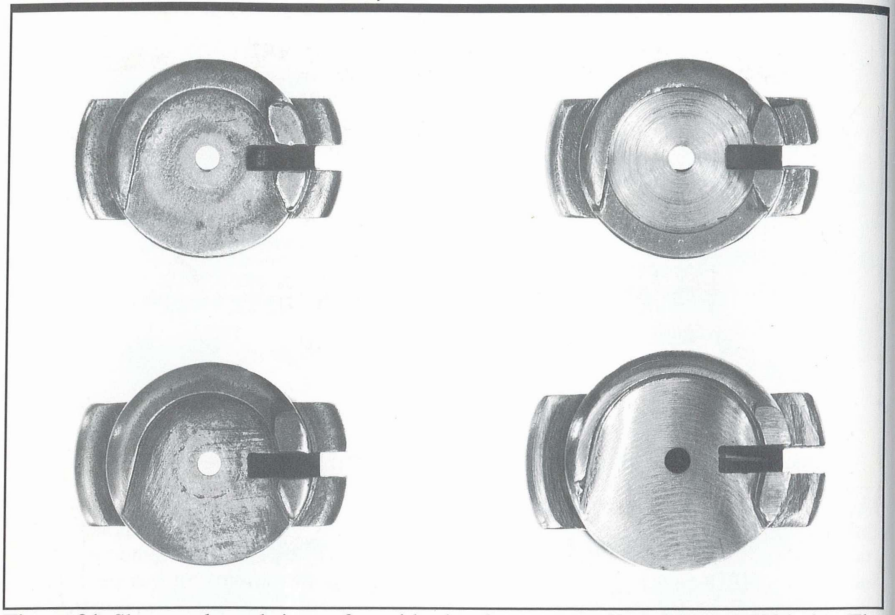


Figure 31- Shows enlarged views of cartridge head recesses and bolt faces in M98 bolts. The corrosion ring shown in the bolt faces at left, was caused by leakage from corrosive military primers. Primer leak corrosion is found, to some extent, on most military bolt faces, and usually looks like a ring of small pits around the firing pin port, or a dark gray, lightly sandblasted circle on the bolt face. The examples shown above are fairly typical of moderate primer corrosion. Both will clean up without excessive resurfacing. Bolt faces can be resurfaced on a one time only basis, providing the bolt face recess is not deepened by more than .010" below the original factory finished dimension. See pages 169 and 170. The bolt face recess in the M98 bolt at upper right was poorly cut and is too deep. **Warning**: polishing and/or adjusting the bolt face surface increases headspace and cartridge case exposure, to greater or lesser degree. Bolt refacing and face truing must not be done unless the work also includes barrel requalification (setback) or barrel replacement. Chambers are then gauged and reamed to correct headspace, using the refaced bolt as reference.

In a standard M98 type bolt, the cartridge head recess opening typically measures about .004" to .005" larger than the .473" diameter of a 7mm or 7.9mm military cartridge rim, and approx. .047" to .050" deep. The cartridge head recess opening in M94/M96 Swedish type bolts typically measures about .004" to .005" larger than the .476" diameter of the 6.5 x 55mm Swedish military cartridge rim and approx. .058" to .060" deep. In M93/M95 type bolts, the cartridge recess opening also typically measures about .004" to .005" larger than a .473" diameter military cartridge rim and approx. .058" to .060" deep. M91 cartridge head recesses are also about .004"-.005" larger in diameter than a .473" military cartridge rim but measure approx. .112"-.113" deep.

In M98 commercial sporters chambered for standard belted magnum cartridges, recess openings, as shown in the M98 commercial sporter bolt at lower right, typically run about .004" to .006" larger than the .532" diameter of a belted magnum cartridge rim. Most Weatherby belted magnum cartridge rims measure .531" in diameter, except the .375 (.530"), the .378" (.580"), and .460 (.582"). Modifying military M98 or other standard length M98 actions to feed cartridges longer than the .30-06 is not recommended. See page 86.

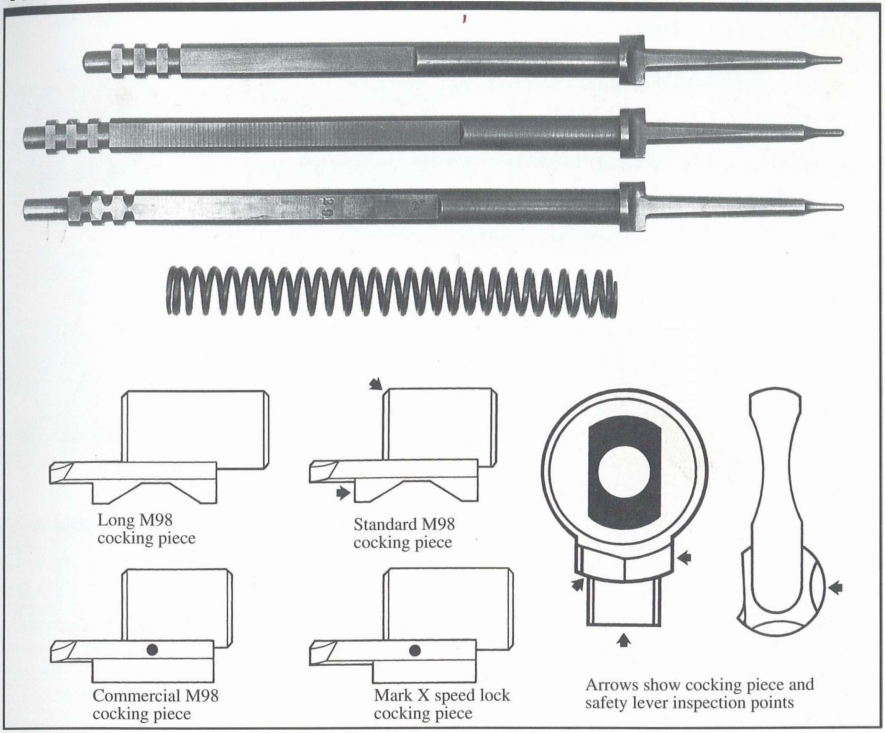
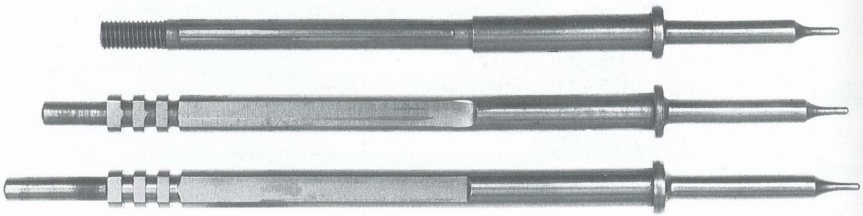


Figure 32- Shows three M98 firing pin variations at top. Unlike previous models, M98 actions have been manufactured in several lengths, including an intermediate length originally designed for the 7x57mm cartridge. Firing pins above are grouped for reference with a standard action (7.337" O.A.L.) M98 firing pin at center. The firing pin at top is from an Oberndorf special order short (kurz) action. The firing pin at bottom is from an intermediate length Peruvian M1909 Mauser. Most commercial magnum length firing pins are about 1/2" longer than the standard firing pin at center. The intermediate length M1909 firing pin, above, has a long cocking piece guide for the long cocking piece that was used on this model. Illustrations at bottom identify standard and long M98 cocking pieces and commercial sporter and Mark X speed lock type cocking pieces. M24, M1910, and M1936 Mexican Mausers and several other models also have shorter than standard firing pins. See Mauser action dimension data, pages 214 and 215. See M98 firing pin and cocking piece checklist below.

1. Inspect M98 firing pin safety lug shoulders- shoulders must be long enough to block firing pin travel until the bolt is locked. Cam surfaces must not be altered or damaged. See page 45.
2. Closely inspect firing pin tip- the tip must be ball shaped, straight, of correct protrusion length, and must not be undersize. See figures 35 and 36.
3. Check the firing pin keys- ideal cocking piece/firing pin key slot fit would permit about .003", or less, endplay. Endplay of .010" is excessive and caused by firing pin key seating and slot stretch. Replace the firing pin and/or cocking piece if excess endplay is present.
4. Firing pin springs must be of correct diameter and length to function correctly. If the firing pin spring is over diameter or too long, spring drag inside the bolt will slow lock timing. Replace oversize or too short firing pin springs.
5. Military type firing pin levers must engage and stop the cocking piece when in safe position. The safety extension must also engage the plunger slot and lock the bolt when the safety is on.
6. Closely inspect the cocking piece- the sear engagement ledge must be at 90° to centerline. If the ledge surface is chipped, pitted, altered, or otherwise damaged, replace the cocking piece.





Typical firing pin spring dimensions:

M91-92	.455"-.460" OD	X 26 turns
M93-95	.455"-.460" OD	X 28 turns
M94-96	.455"-.460" OD	X 27 turns

Most M91~M96 accessory replacement firing pin springs run: .460" OD X 25 or 26 turns

Variations in spring wire gauge size will affect both spring length and spring diameter. Extended coil replacement springs have fewer turns and are longer.

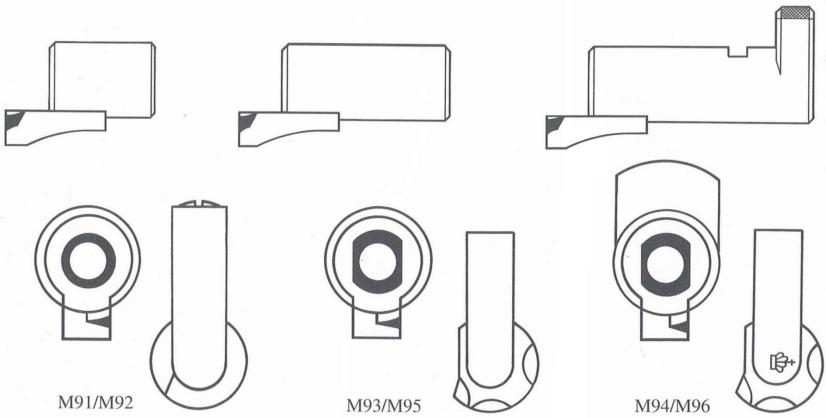


Figure 33- Shows, from top to bottom, Mauser M91/M92, M93/M95 and M94/M96 type firing pins for visual comparison. Original factory and extended coil type replacement firing pin springs are shown below. Firing mechanism inspection points are essentially the same as for the M98 firing mechanism discussed in figure 32. Differences are:

M91/M92 type firing pin and cocking piece threads must be cleaned and closely inspected. M91/M92 firing pins with undersize, altered, damaged, pitted, stretched, or fatigue cracked assembly threads must be replaced. Except for rust damage, M91/M92 cocking piece threads are usually found intact. The M91 safety lever retaining screw, spring, and plunger assembly should be cleaned and checked. If the plunger assembly will not maintain positive safety position after cleaning and reassembly, replace the spring, plunger, and/or screw.

Operating surfaces on M91~M96 cocking piece quarter-cock ramps and sear engagement ledges are very small and must be closely inspected. Quarter-cock ramps and sear engagement ledges are indicated by arrows, above, and discussed in figure 39. Except for normal wear polishing, these hardened, critical surfaces must be in original factory condition. If in doubt, compare with corresponding surfaces in serviceable condition on correct type replacements. Replace the cocking piece if altered, pitted, damaged, or if the engagement ledge has been changed from the original 90°.

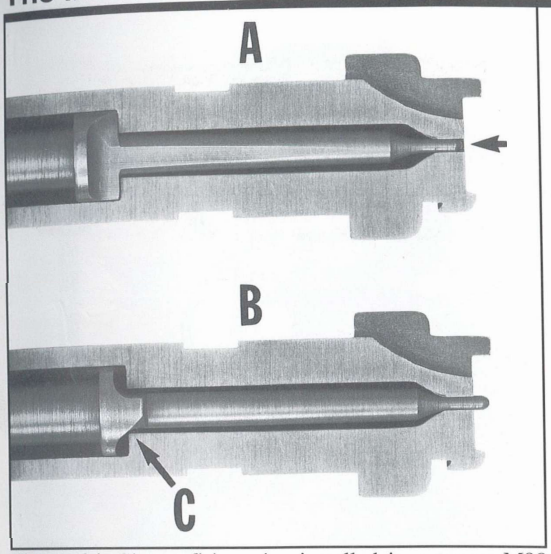


Figure 34- Shows firing pins installed in cutaway M98 bolts. The firing pin, at **A,** is at rest on the bolt's firing pin stop shoulders as it would be with the firing mechanism released in an unlocked bolt. In this position, the firing pin tip should be below the bolt face by .010", minimum. At **B**, the firing pin is in the 90° firing position and all the way forward. If bolt and firing pin are serviceable, the cams, at **C,** will clear the bolt shoulders and secure a 95% closed bolt.

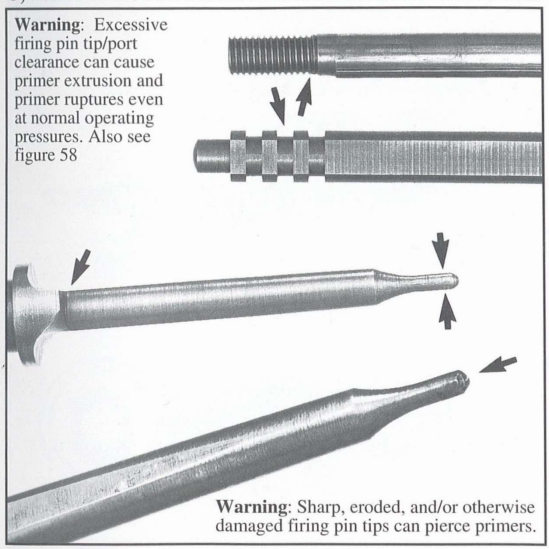


Figure 35- Arrows show M91~M98 firing pin final inspection and deburring areas. Firing pin tips must be straight. Firing pin tip clearance of .002" inside the firing pin port is considered optimum, but requires a straight and uniform diameter firing pin. The M98 firing pin tip, at bottom, is flame eroded. Firing pins in this condition can pierce primers.

Check M98 Firing Pin Safety

Before any further work, M98 type firing pins should be checked to make certain that the bolt and firing pin safety shoulders block firing pin travel until the bolt has been rotated to the locked firing position. This system is designed to secure an M98 bolt and permit firing when the lugs have rotated to the approx. 95% closed position. See figure 34. Function check as follows:

1. Hold the bolt body with split lug up, to simulate locked bolt position.
2. While viewing through gas ports, slide the firing pin in (with a flat side toward you) until the safety shoulders hit the firing pin stops at the end of the bolt well.
3. Hold this position, and check the firing pin tip inside the firing pin port. The bolt/firing pin stop shoulders must hold the firing pin tip at least .010" below the bolt face.
4. Continue holding the above firing pin position while slowly rotating the bolt. The firing pin safety shoulder cams should not begin to engage the bolt clearance slots and permit forward firing pin movement until the bolt body has been rotated to within a few degrees of closed. See figure 34. The firing pin tip shouldn't travel past the bolt face until the bolt is fully locked.

Note: Coordination and careful observation are needed for this check. It becomes easier with practice.

5. Rotate the firing pin 180° and repeat the above check. If the bolt and firing pin pass this test, proceed with steps in figures 35, 36, and 37.
6. If rotation timing is early, and the bolt body is serviceable, replace the firing pin. Parts tolerance variations may require doing this on a on a trial and error basis.
7. If the firing pin tip extends past the bolt face with the firing pin safety lug shoulders pushed against the bolt's internal stop shoulders-

M98 Firing Pin Safety, Cont.

the firing pin could be too long, or even an incorrect M98 subtype. However, if the problem follows the bolt, the bolt well could have been machined too far forward. The bolt body could be off tolerance, altered, or a mismatch. In any case, the bolt body must be replaced.

Check Firing Pin Tip & Tip Clearance in Firing Pin Port

1. Closely inspect firing pin tip. Most slightly bent tips can be straightened. See figures 36 & 37.
2. Even if a firing pin looks perfectly straight, runout check it on the lathe, just the same.

Caution: altered or flattened firing pin tips will not dial indicate correctly, even if the firing pin is straight.

3. Micrometer check firing pin tip diameter and note the measurement for reference. Tips can be checked for roundness by rotating tip in micrometer.
4. Gauge firing pin port diameter with an insert gauge that just fits the port. Find firing pin/pin port clearance by measuring the thickness of the insert gauge and subtracting firing pin tip diameter. M91~M98 firing pin tips that I have measured have varied considerably. Most, however, were in the .074"-.077" diameter range; (.075" was the most common). Firing pin ports ranged from .015" over firing pin tip size to corroded, irregular, and completely unmeasurable.

Firing pin ports in serviceable Mauser M98 military rifles that shot well, measured in the .002" to .003" tip clearance range.

5. If pin tip/port clearance is over .002", trial and error select for larger diameter firing pin.
6. If the port clearance problem can't be solved by replacing the firing pin, replace the bolt body.

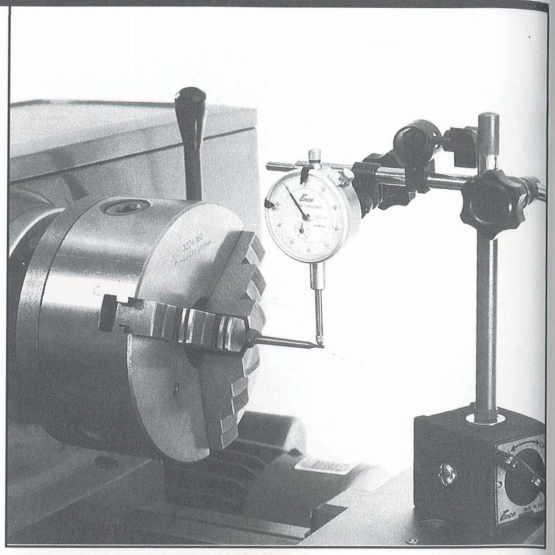


Figure 36- Shows an M98 firing pin chucked in the lathe ready for firing pin tip dial indicator runout check. The lathe chuck is rotated by hand until high spot, if present, indicates at 12:00 o'clock. An aluminum firing pin tip adjusting block, illustrated in fig. 37, is used to bend the tip. The firing pin is indicated and adjusted again until runout is eliminated.

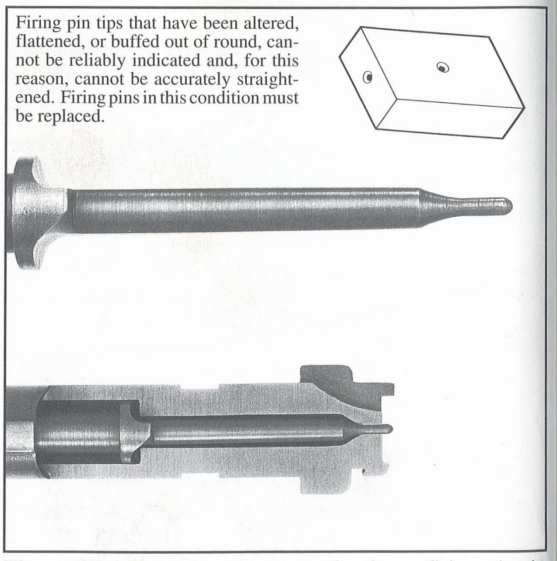


Figure 37- Illustration shows an aluminum firing pin tip bending block, at top. The .080" holes in the side and top of the tip bending block permits hand straightening adjustments in a bench vise or on the lathe. A straightened M98 firing pin with tip trued to correct ball shape is shown below. Always recheck fit in firing pin port after straightening.

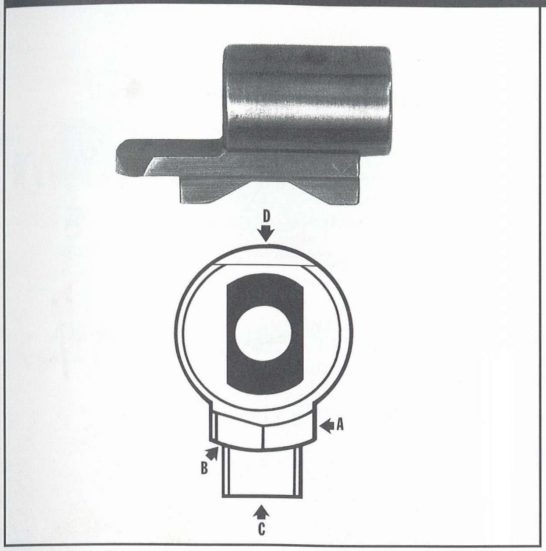


Figure 38- Shows close views of a standard military M98 cocking piece. Important detail inspection points are: cocking ramp, shown at **A**; bolt open hold cock surface, at **B**; sear engagement ledge surface, at **C**; and safety engagement surface, at **D**. Illustration shows an altered safety engagement surface at top of cocking piece. See warning, page 51.

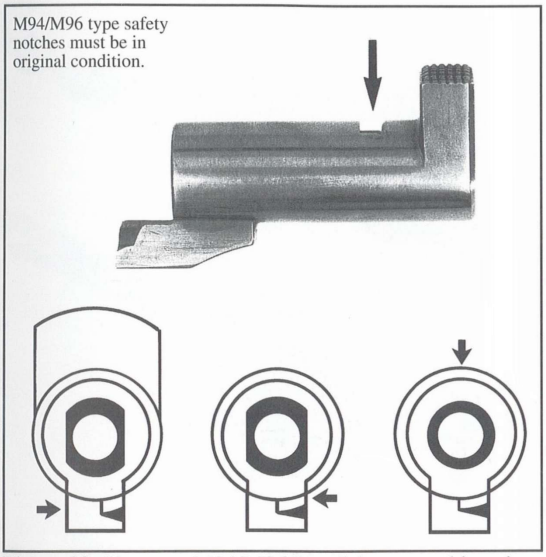


Figure 39- Shows an M94/M96 Swedish type cocking piece at top. Illustrations show front views of M91~M96 cocking pieces for comparison. M91~M96 quarter cock ramps and sear engagement ledges are similar. Inspection points are basically the same as the M98. The M94/M96 safety engagement notch, see arrow, must be in serviceable condition.

Detail Inspect Cocking Piece

Gunsmiths often pay little attention to cocking pieces when inspecting, servicing, or repairing Mauser M91 ~M98 actions. However, when you consider the effects of age, military field servicing and parts wear; the fact that Mauser rifles were made by a large number of manufacturers using different steels and heat treats in making these parts; and that nongunsmiths tend to alter sear engagement ledge angles to "improve" sear release, it would be a gross error not to closely inspect all operating surfaces, and particularly the sear engagement ledge.

If there is doubt about the condition of a cocking piece, compare it with a serviceable similar part.

Inspect cocking pieces as follows:

1. Inspect M98 cocking ramps with a good inspection light and magnifying glass. Only light surface wear polishing should be present, regardless of age. This applies also to the 1/4 cock ramp on M91~M96 cocking pieces.
2. Inspect the unlocked bolt hold cock engagement surface at the extreme front of the cocking piece extension. Only light wear polishing should be apparent here, as well.
3. Closely inspect the sear engagement ledge. Except for light wear polishing, this critical surface must be in original factory condition with sear engagement ledge at 90° to cocking piece centerline. Engagement ledge angle and dimensions must not be altered.
4. Check the cocking piece firing pin safety lever engagement shoulder. This surface (particularly the lever engagement corner) must not be pitted, excessively worn, or altered. Usually, only light polishing to remove lever drag marks is required. See safety warning in figure 46 and function checks on page 52.
5. Check M94/M96 Swedish model cocking piece safety lever engagement notch. The safety lever side of the notch must not be altered, pitted, or excessively worn.

Detail Inspect Cocking Piece, Continued-

Caution: Replace the cocking piece if any of the operating surfaces shown in figures 38 and 39, or the firing pin assembly keys inside, are found to be pitted, misfit, altered, or damaged- or if an operating surface is apparently soft. In cocking pieces that are not correctly heat treated, engagement and operating surfaces can appear to be galled, excessively worn, or indented.

About Firing Pin Springs-

Firing pin spring turn counts and wire gauge sizes found in M91~M98 actions vary considerably. This probably stems from a viewpoint held by some maintenance personnel that a spring is just a spring.

Firing pin spring strength, in pounds, is rated with the firing mechanism cocked. Firing pin spring length is more important than wire gauge size or the specific number of turns.

The following basic rules are important in M91~M98 action firing pin spring selection:

1. Firing pin spring tension must never be so light that it causes trigger pull to be below 4 pounds- or that insufficient cocking piece /sear engagement pressure permits impact sear releases or slam fires as the bolt is closed. Also see figure 104 regarding sear springs.
2. On the other hand, firing pin spring tension should not be heavier than needed to produce reliable and consistent primer ignition when firing pin protrusion, chamber headspace, and ammunition are correct. The exception to this is that a slightly higher poundage spring installed in a Mark X speed lock firing mechanism will effectively shorten lock timing.
3. Spring length, diameter, or number of turns should not be so great that "S" curves result and the firing pin spring drags inside the bolt well or on the firing pin shank. Ideally, firing pin spring I.D. should be approx. .005" larger than the firing pin shank to prevent spring drag.

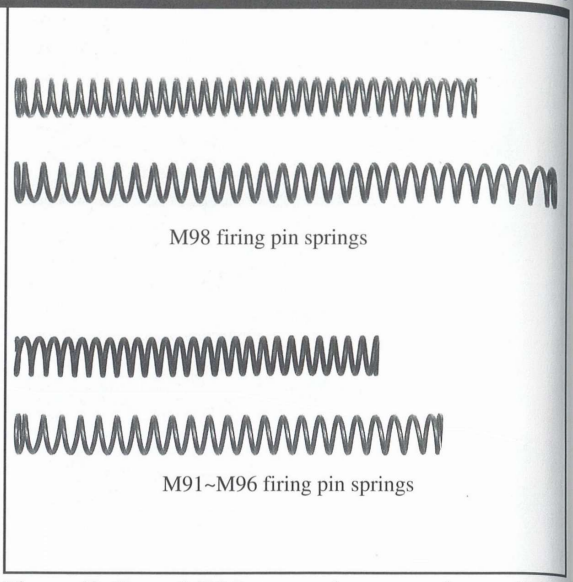


Figure 40- Shows M98 factory and accessory long coil type firing pin springs, at top. M91~M96 factory and long coil accessory firing springs are shown below. When sized to the correct length, long coil firing pin springs are less inclined to coil bind and offset into "S" curves. With these improved springs, firing pin travel is smoother and usually faster.



Figure 41- Shows a cocked M98 firing mechanism with a fully compressed long coil spring, at top. The M98 firing mechanism below is uncocked. Note that long coil firing pin springs "S" curve very little when compressed. As a result, spring drag on the firing pin shank and inside the bolt well is minimal. Rough bolt wells can be lightly honed. **Caution**: Buttress bolt assembly thread tops must not be undersized.

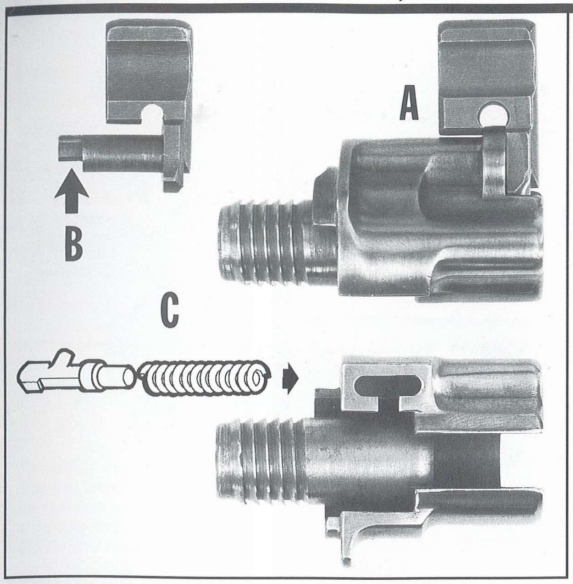


Figure 42- Shows a close view of an M98 military type cocking piece with firing pin safety lever installed, at **A**. The safety lever must move smoothly on the retaining flange and have slight endplay. The safety lever locking cam, at **B,** must lock the bolt when the safety is on. The bolt sleeve lock plunger, at **C**, is installed in the bolt sleeve at this time.

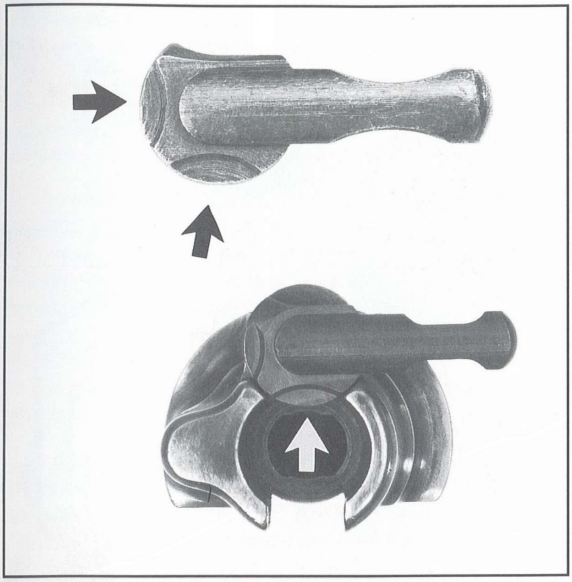


Figure 43- Shows an M98 firing pin safety lever, above. Arrows show safety lever, safety, and disassembly detents. The lever's cocking piece engagement cam is shown at top. Cam angle is adjusted if lever operation is stiff or if the lever can't be turned to the disassembly or safe positions. An M98 safety lever is shown in safe position in bolt sleeve, below.

Check M93-M98 Bolt Sleeve and Firing Pin Safety Lever

1. Replace bolt sleeves and/or safety levers that are pitted, misfit, altered, or damaged. If there is any question about the condition of a Mauser part, compare it against a correct model part in serviceable condition.
2. Closely inspect the bolt sleeve assembly threads. The buttress type threads must be in original condition. Remove nicks and deburr only, but do not remove material from the tops of the threads. Detail clean the bolt sleeve recesses and threads with solvent and a brass brush.
3. Check to ensure that the safety lever and lever pivot stem are straight. If bent, the lever will drag on the sleeve retaining flange. The pivot may also drag or bind inside the sleeve body. The bolt locking cam at the end of the pivot stem, see figure 42, must secure the bolt when the safety lever is in the safe position. Replace the safety lever if it is bent beyond slight straightening or if the locking cam will not secure a serviceable bolt.
4. The bolt sleeve retaining flange must not allow the safety lever to escape except when aligned with the installation clearance slot on the right side of the sleeve. If the flange has been misfit, altered, or buffed undersize, replace the bolt sleeve.
Note: Safety lever endplay of about .010"-.015" on the bolt sleeve's safety lever retaining flange is typical and needed for smooth safety lever operation.
5. Check M98 bolt sleeve lock plunger and plunger spring fit inside the sleeve's lock plunger tunnel.
6. M98 bolt sleeve lock plungers and springs must move freely. If travel is resistant, polish the inside sleeve tunnel walls with a medium craytex rod.
7. Check M93~M98 safety lever pivot stem fit inside the bolt sleeve pivot tunnel. Detail tunnel walls as needed with a craytex rod for smooth pivot stem movement.

Check M91/M92 Bolt Sleeve and Firing Pin Safety Lever

Basic M93~M98 bolt sleeve and safety lever checks apply. M91/M92 differences are:

1. M91/M92 safety levers are retained with a plunger assembly inside the lever. See figure 45.
2. The plunger also engages the safety detent in an M91/M92 type cocking piece which is milled into the bolt sleeve plunger slot, not into the safety lever itself.
3. M91/M92 safety levers are two position only. There is no disassembly position.

Note: M91's are sometimes found with M93, or later, firing mechanisms. These unofficial field updates are usually workable, but must be checked to make sure the firing pin was adjusted to correct protrusion length and that cocking piece ledge and sear engagement is correct. Check actions modified in this way for safe trigger pull and to make sure that they do not impact fire or slam fire. Also see figs. 116, 249, & 250.

About Stiff Safety Levers-

If M93~M98 safety operation is stiff or the lever won't move to the disassembly and safe position, the safety engagement cam may need polishing or adjustment.

1. Inspect the top front of the cocking piece for roughness, galling, or ridges caused by lever contact.
2. Detail the cocking piece safety engagement surface with a fine stone, but do not undersize the surface or alter the cocking piece. See safety warnings in figure 46.
3. Inspect the safety engagement cam on the safety lever. Deburr the cam surface and lightly polish with a fine stone.
4. Then, reassemble the bolt and check for smooth safety lever and cocking piece engagement.
5. If operation is still stiff or resistant, carefully adjust safety engagement cam angle, then repolish and recheck function. Repeat adjustment until engagement is smooth. See figures 49 and 50.

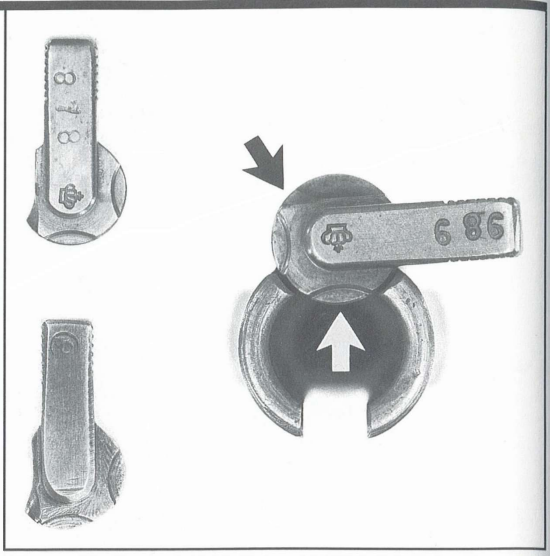


Figure 44- Shows M94/M96 and M93/M95 safety levers at left. Although M93~M96 lever dimensions are different, detents are the same as on a standard M98 lever. An M94 bolt sleeve with safety lever in safe position is shown, at right. Cocking piece safety lever engagement cam location, see arrow, is also at top. See figs. 49 and 50 for cam adjustment.

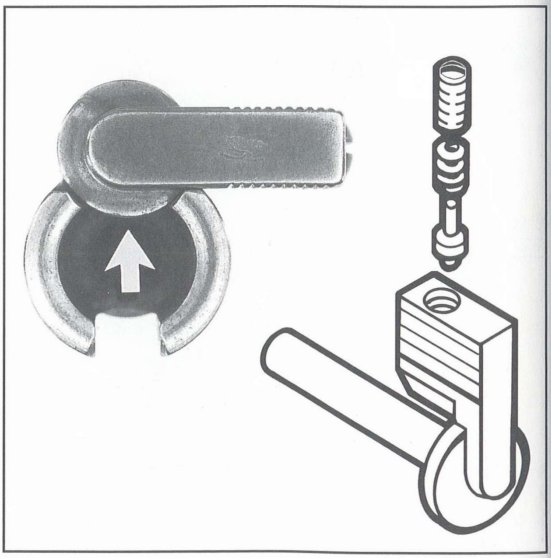
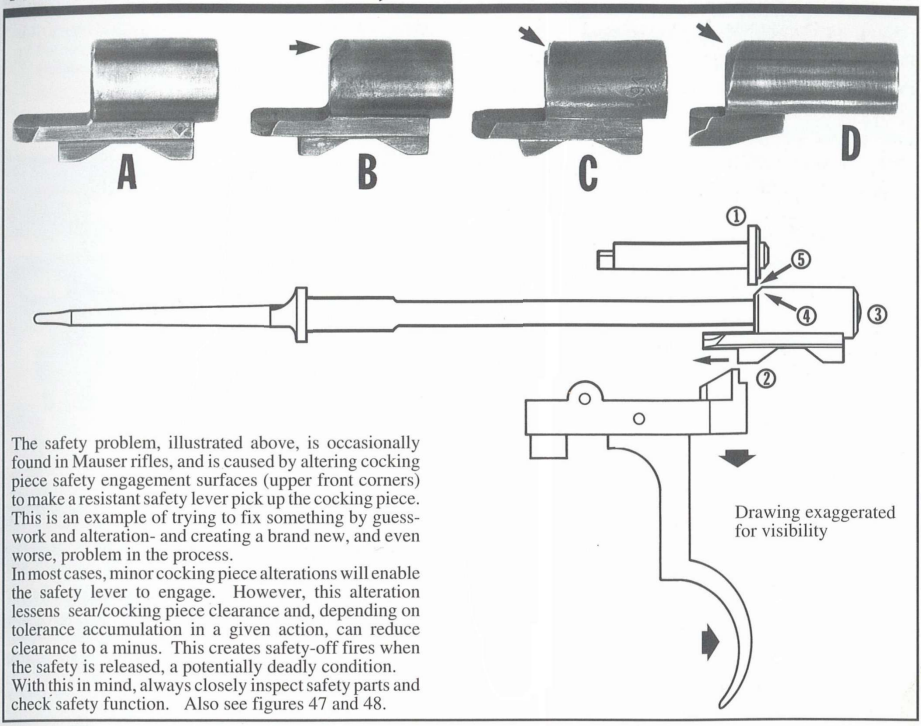


Figure 45- Shows a close view of an M91 bolt sleeve with safety lever installed and placed in safe position. The parts illustration, at right, shows an M91 type safety lever plunger detent assembly. Note that there is no safety detent on the lever; instead, the safety lever plunger engages a detent in the plunger slot on the right side of the cocking piece.



The safety problem, illustrated above, is occasionally found in Mauser rifles, and is caused by altering cocking piece safety engagement surfaces (upper front corners) to make a resistant safety lever pick up the cocking piece. This is an example of trying to fix something by guesswork and alteration- and creating a brand new, and even worse, problem in the process.
In most cases, minor cocking piece alterations will enable the safety lever to engage. However, this alteration lessens sear/cocking piece clearance and, depending on tolerance accumulation in a given action, can reduce clearance to a minus. This creates safety-off fires when the safety is released, a potentially deadly condition.
With this in mind, always closely inspect safety parts and check safety function. Also see figures 47 and 48.

Figure 46- Shows an M98 cocking piece, at **A**, with the original 45° safety lever engagement corner in unaltered 45° factory chamfered condition. The engagement corner surface has been only lightly polished to make safety lever cam engagement smoother. The M98 cocking piece, shown at **B**, was altered (bevelled) unnecessarily in an incorrect attempt to solve a stiff or resistant safety lever function problem. The M98 cocking piece, at **C** , has a slot filed into it- probably for the same reason. The M93/M95 cocking piece, shown at **D**, was ground almost into the key slots.

Removal of metal from the cocking piece safety engagement corner causes the cocking piece sear engagement ledge to rest further forward on the safety lever. This reduces the normal clearance between the cocking piece engagement ledge and the sear. If clearance is reduced enough, it will permit the cocking piece sear engagement ledge to move or slide forward ahead of the sear, blocking sear re-engagement if the trigger is touched or manipulated with the safety on. Once the sear has been disconnected and blocked in this fashion, the trigger is no longer functional. Only the altered cocking piece safety engagement corner (whatever its final shape) holds the firing mechanism in cocked position. This condition forces the safety lever to act as a substitute trigger and sear.

The illustration, above, shows the sequence of events that could occur when an altered cocking piece was installed, the bolt closed, and the trigger manipulated or cycled with the safety, at **1**, in the safety-on position. The lowered sear, at **2**, would permit the cocking piece, at **3**, to move forward (bypassing the sear) until the altered safety engagement corner, at **4**, came to rest against the safety lever safety detent, at **5**. At this point, the safety lever would actually become a substitute trigger and sear. The sear would then be incapable of re-engaging the cocking piece sear engagement ledge because the ledge would have moved too far forward and, being on top of the sear, would physically block it.

The potentially deadly result of cocking piece safety lever engagement alteration as discussed above would be that the firing mechanism would release the instant the safety lever was turned to the ready to fire position. If a cartridge was chambered in a rifle in this condition, it would fire.

Check M91~M98 Military Firing Pin Safety Function

Preassemble bolt for this test and verify unloaded chamber status. Before checking, see figures 46-48. This check is basically the same for all M91~M98 models.

1. Install bolt assembly and close and cock the bolt. Rotate the safety lever to the safe position.
2. If safety lever cam pickup of the cocking piece is stiff, resistant, or the lever won't move, correct as shown in figures 49 and 50.
3. If the bolt will open with the lever in the safe position, inspect the bolt lock cam at the end of the safety pivot stem and the locking notch in the bolt body. Replace defective bolt body or safety lever.
4. Then check cocking piece/sear clearance. The best way to do this is to install a minimum clearance sear gauge (a standard dimension sear body with a piece of .030" gauge stock soldered to the sear face).

Check as follows:

A. Cock the bolt and place the safety lever in the safe detent. Then pull the trigger back and release. The firing mechanism must not click or slip forward. If it does, clearance is less than gauge size. If the sear does not click and the firing mechanism does not move forward, and the trigger will move the sear gauge up and down without contacting or dragging the gauge on the cocking piece sear engagement ledge, clearance is greater than .030".

With military type triggers and firing pin safety systems, .030" is suggested as a minimum sear clearance specification. Probably more than 50% of actions checked will have even greater clearance. See fig. 47.

B. If sear clearance is below minimum, recheck with a serviceable replacement cocking piece of the correct model type.

C. If this doesn't work, a tolerance accumulation problem exists. Solve by adjusting the cocking piece engagement ledge on the mill and rehardening the surface. Always recheck sear clearance after cocking piece or sear replacement.

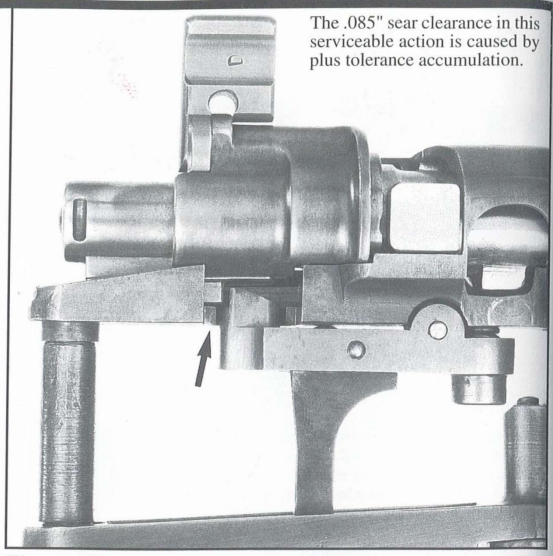


Figure 47- Shows the cocking piece in a cutaway M98 action set back by placing the safety lever in the disassembly position. Cocking piece/sear clearance in the above action is .085". In a serviceable action, sear clearance is the same in the safety and disassembly detents. In the disassembly position, the bolt can be cycled to check sear clearance.

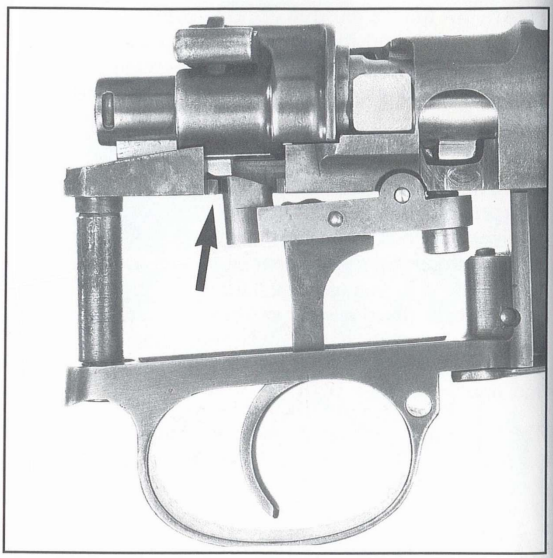
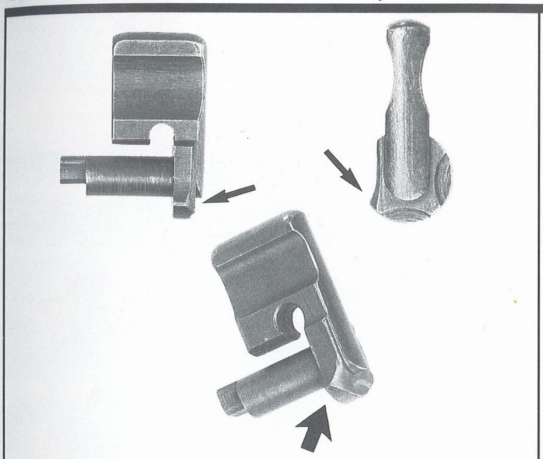


Figure 48- Shows the sear in a cutaway M98 action blocked by a cocking piece that moved forward when the trigger was cycled while the safety lever was in the safe position. This was caused by an altered cocking piece sear engagement corner which reduced cocking piece/sear clearance to zero, or less,when the safety lever was in the safety detent.



Deburr the flat bearing surfaces on the bolt sleeve and on the back side of the safety lever before adjusting the engagement cam. Use caution when adjusting engagement cams. Do not overcut or cut into the disassembly detent.

Figure 49- Shows M98 firing pin safety levers and cocking piece engagement cam surfaces. Cam angle is adjusted forward to pick up the cocking piece safety engagement surface when safety lever operation is stiff or the lever won't move. A Foredom tool and small grinding point can be used to make initial adjustments. Cam surface height can be reduced slightly if needed. Finish with a 1/4" round fine stone.

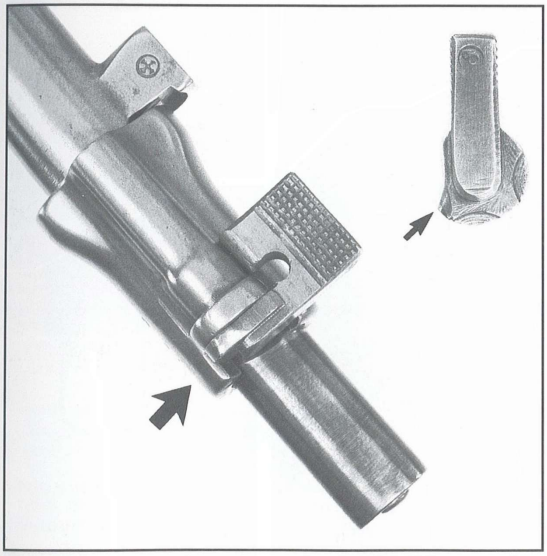


Figure 50- Shows close views of an M93/M95 type safety lever with engagement cam that has been angled forward about .040" to compensate for tolerance accumulation and parts wear. The cam surface is carefully ground forward until it just picks up the cocking piece. The surface is then lightly stoned and final polished with a medium craytex rod.

Adjust Firing Pin Safety Lever Cocking Piece Engagement Cam

The firing pin safety lever cocking piece engagement cam is angled and adjusted forward to improve cocking piece pickup when safety lever engagement is stiff, resistant, or when the safety lever will not engage. See figures 46 through 50.

Caution: The cocking piece safety engagement surface must not be modified. Only a light polishing of the 45° engagement bevel at the top front corner of the cocking piece is needed. The cocking piece must not be further fit or altered in any way.

1. Closely inspect the flat bearing surface on the front of the safety lever. Deburr edges and level ridges and high spots with a fine stone.
2. Check the lever bearing surface on the bolt sleeve. Level high spots and deburr, as above. Steps 1 and 2 must be done first to make sure that a safety lever engagement problem wasn't caused by the safety lever being too far back due to roughness of the bearing surfaces.
3. Reassemble the bolt and check for possible improvement in cam/cocking piece pickup and safety lever engagement.
4. If pickup isn't improved, estimate the amount the safety lever engagement cam must be angled and adjusted forward to function correctly with the cocking piece.
5. Then grind half the estimated amount , as discussed in figures 49 and 50, and recheck function.
6. Continue adjustment until the lever engagement cam surface just begins to pick up the cocking piece.
7. Then, break sharp edges and deburr the new cam surface with a fine 1/4" round stone.
8. Reassemble bolt and check cocking piece friction track across the new engagement cam surface. Concave shape with a round stone. Polish with a medium craytex rod.

Assemble M93 through M98 Firing Mechanisms

M93~M98 firing mechanism reassembly (see figure 51) is the reverse of the disassembly process shown in figures 16 through 22.

If the cocking piece is resistant, will not slide forward onto the firing pin, or won't turn 90° and key lock, inspect and detail as follows:

1. Check for hardened dirt in the cocking piece key slots. Detail clean with solvent and a brass brush.
2. If key slots inside the cocking piece are nicked or flanged, dress with a small pattern file. Do not round off edges or oversize.
3. Closely inspect the firing pin key slots. Level rough, flanged, or burred areas at round key surfaces and flat sides with a fine stone. Deburr key slot corners, but do not round off or undersize the corners.
4. Then, polish the round tops of the firing pin key surfaces with #400 sandcloth.
5. If the cocking piece is still resistant, check and deburr the round firing pin alignment hole inside the cocking piece.
6. Also inspect the round alignment extension on the back of the firing pin. Remove nicks, burrs, and high spots that would affect cocking piece installation. Do not undersize the extension. Straighten if slightly bent.

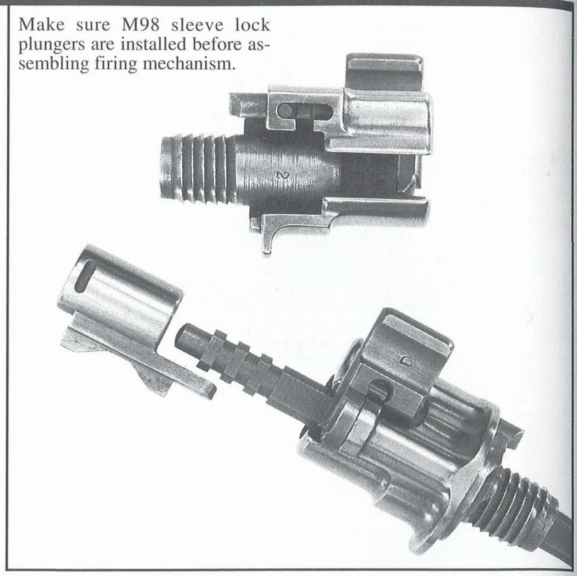


Figure 51- Shows reassembly of an M98 firing mechanism. Install the cocking piece by aligning it with the firing pin key slots, sliding into position, and then turning it 90° to engage the keys. M93~M96 firing mechanism assembly is the same. Burrs or flanging at the firing pin keys can make the cocking piece hard to install and should be removed before assembly.

Assemble M91/M92 Type Firing Mechanism

M91/M92 firing mechanism reassembly (see figure 52) is the reverse of the disassembly process shown in figures 19, 20, and 23. Before reassembly make sure that the cocking piece and firing pin threads are clean and serviceable.

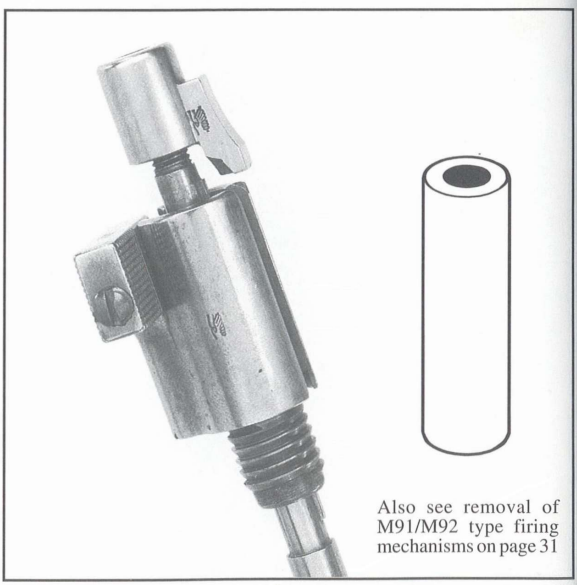
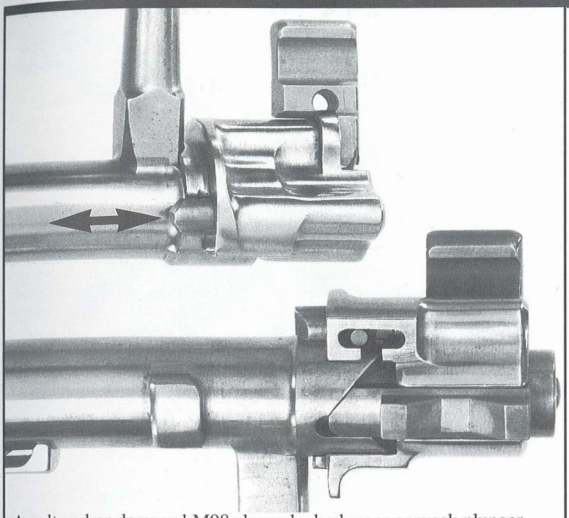
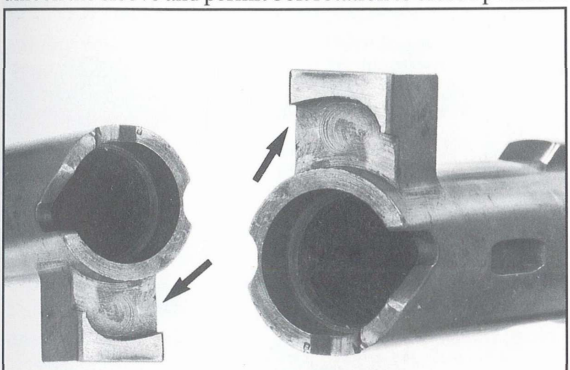


Figure 52- Shows an M91/M92 type firing mechanism being reassembled. The spring compressor tool, shown at right, is placed on the front of the firing pin. The bolt sleeve is then threaded in to expose the firing pin assembly threads in order to screw on the cocking piece. The C.P. is retained with a shim and the sleeve is unsrewed to remove tool.



An altered or damaged M98 sleeve lock plunger or weak plunger spring could fail to lock the bolt sleeve. An oversize or damaged lock plunger can drag or bind on the bolt body as the sleeve is turned.

Figure 53- Shows M98 bolt sleeve lock plunger check, at top. The firing mechanism, below, open bolt decocks because of an undersize lock plunger.The lock plunger assembly must index with the locking slot in the bolt body and lock the bolt sleeve and firing mechanism as the bolt is rotated upward to stop. Pushing the plunger in 1/3 or more should unlock the sleeve and permit bolt rotation to closed position.



M91~M96 models do not have the M98 bolt sleeve lock feature discussed in figure 53. These bolts 1/4 cock with 90° rotation (but also decock if bolt is closed without drawing it back). If any model Mauser bolt decocks with the bolt open, the cocking piece will hit the receiver rail if an attempt is made to close the bolt. Later decocks are usually slam fires caused by altered or weak firing pin springs, trigger/sear springs, altered or damaged sears and/or cocking pieces.

Figure 54- Shows an M93/M95 bolt stop, at left, and an M94/M96 bolt stop, at right. This stop design was used on the M91~M96 models. The stop milled into the back of the bolt shank, see arrows above, limits bolt rotation when the stop contacts the bolt sleeve. Open bolt decock is prevented by cocking piece engagement in the bolt's 1/4 cock notch.

About M98 Bolt Sleeve Locks

The M98 bolt sleeve lock plunger indexes with the safety slot machined into rear of the bolt body and holds the firing mechanism aligned with the receiver when the bolt is cycled. As the bolt closes, the plunger is pushed back by the receiver, unlocks, and permits the bolt to rotate to the closed position. Some early M98 sporters did not have this feature. Instead, the front of the cocking piece engaged in a shallow slot at the back of the bolt. Both the bolt and the cocking piece must match for this early system to work.

About M91~M96 Bolt Stops

M91~M96 bolts stop at 90° upward rotation as the bolt stop, machined into the bolt shank, comes to rest against the bolt sleeve. See figure 54. Just before the bolt stops, the cocking piece drops into the quarter cock slot in the bolt body and retains the firing mechanism so the bolt can be cycled.

Note: M98 bolt sleeve locks and M91~M96 bolt stop/quarter cock systems are important for the following reasons:

1. In M98's, the firing mechanism full cocks with 90° bolt rotation. The cocking piece and bolt sleeve lock act together to hold the firing mechanism in the open bolt cocked position as the bolt is cycled. The plunger releases the bolt so that the cocking piece can engage the sear as the bolt is closed.
2. In M91~M96 models, the firing mechanism is quarter cocked as the bolt is rotated upward 90°. To hold this position, the cocking piece engages in the 1/4 cock notch in the back of the bolt, but would overtravel past the 1/4 cock notch without the bolt stop.

Warning: Always inspect and function check these systems before loading or test firing.

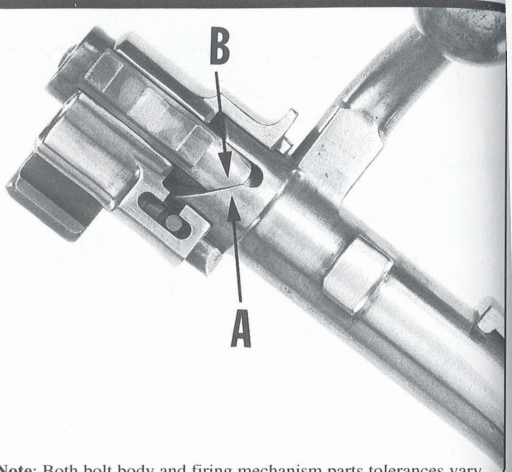
Uncock Bolt for Firing Pin Protrusion Check

1. Inspect and detail cocking piece and bolt body as shown in figure 55.
2. Secure bolt assembly in a bench vise between soft aluminum pads.
3. Uncock an M98 type bolt by pushing in on the sleeve lock plunger and rotating the bolt sleeve until the firing mechanism snaps forward into the cocking cam slot in the bolt body. **Caution**: Prevent injury by keeping fingers well clear of the firing mechanism as the bolt uncocks.
4. Uncock M91~M96 bolts by drawing the cocking piece engagement ledge back about .050" and turning the bolt sleeve until the firing mechanism snaps forward into the quarter cocking cam slot machined into the bolt body. See finger caution, in #3, above.

Check Firing Pin Protrusion

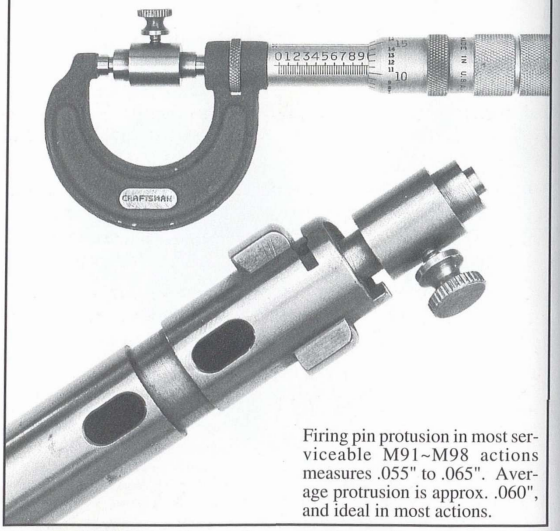
1. Begin with bolt body between soft aluminum vise jaw pads as in #1, above, with bolt face and extended firing pin pointing upward.
2. Measure length of closed firing protrusion gauge shown in fig. 56.
3. Push the gauge down over the firing pin until the gauge body rests solidly against the bolt face surface.
4. Lock the extended gauge center in this position. Then, remove the gauge and measure overall (extended) gauge length. Subtract the length of the closed gauge from the length of the extended gauge - the difference equals basic firing pin protrusion.
5. Then, check for endplay in bolt body/bolt sleeve assembly threads and cocking piece/firing pin key slots by pushing the back of the cocking piece hard forward.
6. If even slight endplay is detected, measure protrusion a second time with the cocking piece held all the way forward. The difference found between the first and the second measurement would equal the amount of endplay and firing pin inertial overtravel present.

See inertial firing pin overtravel and total protrusion on page 57.



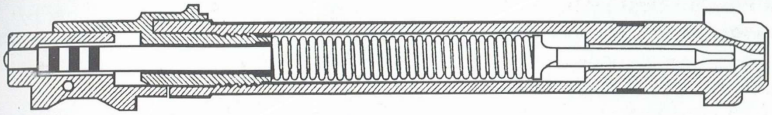
Note: Both bolt body and firing mechanism parts tolerances vary considerably. For this reason, a firing pin protrusuion test would be valid only for an individual bolt body/firing mechanism assembly. Replacement of even one part could change protrusion.

Figure 55- Shows an M98 firing mechanism in uncocked position, ready for the firing pin protrusion check. The cocking piece is held fully forward to accurately measure total protrusion. Surface nicks and/or burrs at the bolt's cocking cam, at **A,** and at the cocking piece cocking ramp, at **B**, must be removed before checking firing pin protrusion. See figure 56 and 57, and note above.



Firing pin protusion in most serviceable M91~M98 actions measures .055" to .065". Average protrusion is approx. .060", and ideal in most actions.

Figure 56- Shows firing pin protrusion being checked with a protrusion gauge. The closed gauge is first measured with a micrometer. Extended gauge length is then measured after gauging basic and total firing pin protrusion. The difference between closed and extended gauge measurements equals firing pin protrusion. See figures 55 and 57. Protrusion gauges are available from **Brownells, Inc.**



A B

Mauser M91~M98 firing mechanisms are not inertial (firing pins are retained and do not float). But, when excess clearance and endplay exist at the firing pin and cocking piece key slot junction or at the bolt sleeve/bolt body assembly threads, firing pin travel can exceed protrusion as standardly measured in figure 56.

Excessive clearance causes inertial firing pin overtravel which is additive to basic protrusion, and, if great enough, can cause primer punctures when basic firing pin protrusion is near limit of .065". The remedy involves simply replacing the loose fitting firing pin and cocking piece or bolt sleeve and/or bolt body on a trial and error basis until excessive clearance is eliminated. Overtravel of .010", or less, can be remedied by shortening the firing pin tip until firing pin protrusion measures between .055" and .065" with the firing mechanism held hard forward.

Total firing pin protrusion (firing mechanism pushed hard forward) measured .093" in the M98 bolt, at right. This firing mechanism punctured or cracked primers in every cartridge fired.



Figure 57- Half sectional illustration shows a commercial M98 firing mechanism in the cocked position. In most M91~M98 actions in serviceable condition, total clearance at the firing pin/cocking piece key slots, at **A**, and the bolt sleeve assembly threads, at **B,** does not exceed approx. .010". When the firing pin is released and moves forward, inertia causes the firing pin to take up all clearance present in the firing mechanism. However, excessive clearance at **A** or **B** creates endplay in M91~M98 firing mechanisms and enables firing pins to overtravel.

Firing pin inertial overtravel, whatever the amount, must be added to firing pin protrusion. Most firing pin protrusion measuring devices push back on the firing pin, and, as a result, exclude endplay and resulting overtravel from the measurement. For this reason, firing pin protrusion in Mauser M91~M98 bolts should be measured twice: once to determine basic protrusion, and a second time with the firing mechanism pushed hard forward to determine the amount of clearance/overtravel that would be present on firing.

If, for example, basic protrusion measures .055" and total protrusion with the firing mechanism pushed hard forward measures .065", overtravel would be .010". Because suggested maximum protrusion is .065", firing pin tip adjustment probably would not be necessary in this case.

In the majority of the serviceable M91-M98 actions checked, firing pin protrusion was in the normal .055"-.065" range. Ignition was most consistent, and primer problems nearly nonexistent, when the firing pin tip was ball shaped, total protrusion was approx. .060", headspace was between go and no-go, and total firing pin/firing pin port clearance was .003" or less.

Short firing pin protrusion can cause erratic primer ignition and/or misfires. Excessive protrusion can crack or puncture primers. Pierced primers vent hot, high pressure gasses into the receiver, erode firing pin tips and firing pin ports, and can vent into the shooter's face, depending on circumstances.

Factors that affect firing pin protrusion are listed below.

Firing Pin Protrusion Too Short:

1. The firing pin tip is too short
2. The firing pin tip taper hits inside the bolt body
3. M98 bolt firing pin safety shoulder slots are too short or impacted with foreign material
4. The firing pin hits the end of the bolt well
5. Wrong firing pin installed for action or bolt body

Firing Pin Protrusion Excessive:

1. The firing pin tip is too long
2. Inertial overtravel caused by loose bolt/sleeve thread fit
3. Inertial overtravel caused by loose firing pin/cocking piece fit
4. Wrong firing pin installed for action or bolt body
5. The bolt face recess has been refaced

Firing Pin Tip Problems

Some M91~M98 firing pins are found in near factory condition with their half spherical shaped tips intact. Many are found with pitting caused by salts residue from leakage of corrosive military primers. Pitting can make firing pin tips rough or sharp. Sharp firing pin tips can crack or puncture primers. The resulting escape of high temperature combustion gasses and carbon particles causes further tip erosion. See figure 59. Firing pins are often found with tips that have been stoned or buffed until they are off center, pointed, and/or undersize. If still long enough to fire a chambered cartridge, these firing pins can cause problems such as those in figure 58. Primer punctures and cracks are primarily caused by firing pin related problems and/or excessive pressures. Reloaders sometimes fault primers for these problems, defective primer cups, however, are rare.

Check and Dress Firing Pin Tip

Pitted, eroded, or sharp, firing pin tips are remedied as follows:

1. Chuck the firing pin in the lathe. Indicate concentricity and straighten pin as needed. See figures 36 and 37. Replace firing pins with tips that are not round and can't be straightened.
2. Check protrusion as discussed in figures 55 through 57.
3. If firing pin tip diameter is large enough and the tip is long enough so that protrusion of .055" or greater, would remain after reshaping and polishing, the tip can be dressed as discussed in figure 59.

Caution: Remove only enough material to shape and polish the tip to the correct ball shape. Total protrusion must not be reduced below the minimum of .055".

4. If firing pin protrusion is already .055" or less, and the tip is pitted, eroded, sharp, and/or misshapen, not enough material would remain to dress the tip. Replace the firing pin.
5. Check firing pin fit and tip clearance inside the firing pin port. See pg. 46. Repeat any steps needed.

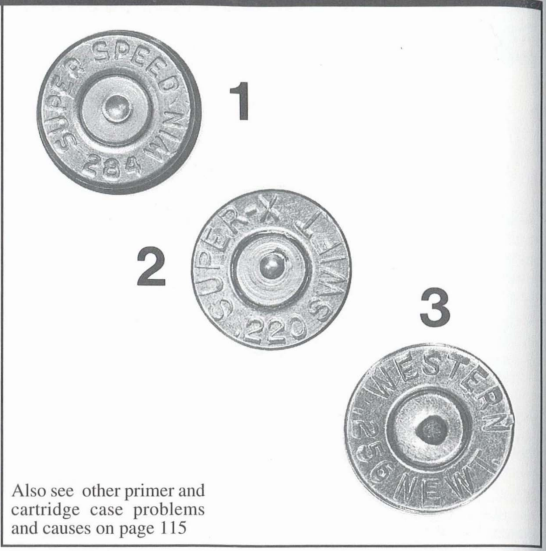


Figure 58- Shows evidence of firing pin problems in fired primers, above. The primer extrusion, at **A**, was caused by an oversize firing pin port or undersize firing pin. The primer, at **B**, shows the beginning of cracking caused by an eroded and sharp firing pin tip. The punctured primer, at **C**, was caused by excessive firing pin protrusion.

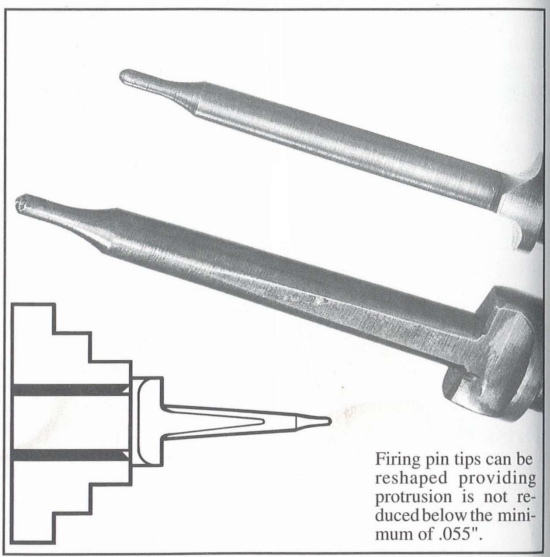


Figure 59- Shows a sharp firing pin tip, at center, that was pitted by corrosive primer leakage and further damaged by gas erosion from pierced primers. The firing pin tip, at top, has been dressed to the original ball shape. Firing pins that are long enough can be chucked directly in the lathe,as shown below, for tip reshaping and polishing.

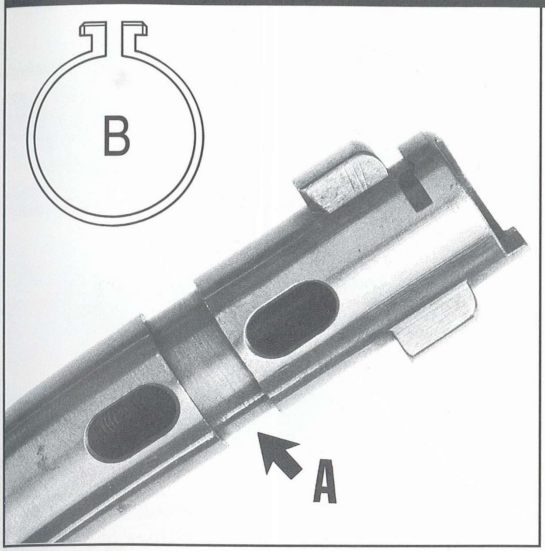
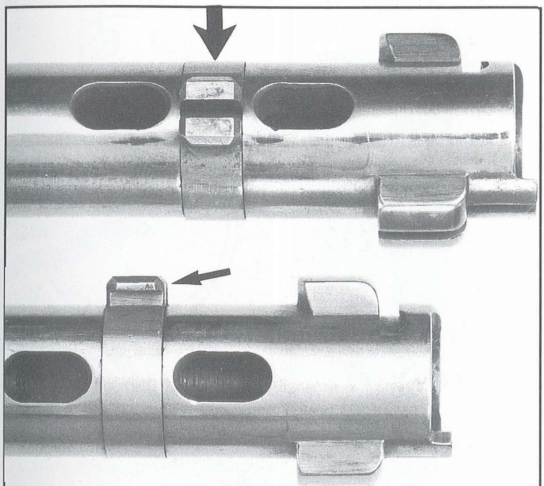


Figure 60- Shows a close view of the extractor ring recess in an M98 bolt body. Rough or high spots at the sides and bottom of the recess, at **A**, are levelled to minimize extractor ring drag. Extractor ring inside corner edges, at **B**, should be lightly broken. Inside walls should be lightly polished with a #400 sanding wheel to prevent extractor ring clutching.



Extractor rings that have misfit, damaged, or undersized keys or that are out of round enough to cause the ring to drag or bind, must be replaced. When installed, side clearance of .003"-.004" is suggested.

Figure 61- Shows views of extractor key engagement surfaces on M98 extractor rings. Tight key engagement surfaces can be carefully adjusted with a 1/2"x1/2" fine stone to make extractor installation easier, but must not be undersized. If extractor fit is loose, key surfaces can be lightly peened to position the extractor closer to the bolt body.

Check Extractor Ring Fit

Extractor rings should fit the bolt's extractor ring recess with nearly zero clearance and with minimum sideplay; but the ring must not fit so tightly that it clutches or binds the bolt when the extractor is installed. The extractor ring must hold the extractor close to the bolt body for smooth bolt function and correct extractor operation. However, the extractor must not drag on the bolt body at the extractor ring/extractor junction.

Check fit as follows:

1. Closely inspect the extractor ring. Replace the ring if misfit, undersized, damaged, and/or out of round to the extent that the ring drags in the bolt's ring recess.
2. Inspect the extractor ring recess in the bolt body. Level any rough areas or high spots found with a 1/4" x 1/4" fine stone. But do not widen or deepen the ring recess.
3. Polish and level both sides of the extractor ring on #400 sandcloth to provide approx. .003"-.004" (total) extractor ring clearance in the bolt recess.
4. For smooth operation, lightly break sharp inside corner edges and polish the flat inside ring surface with #400 sandcloth. See figure 60.
5. Install the extractor ring on the bolt body and squeeze tight with a soft jaw clamp. Reshape slightly out of round areas by lightly peening the outside of the ring with a plastic hammer.
6. Reduce clamp pressure to simulate an installed extractor. Apply oil and rotate the ring to final polish and mate surfaces.
7. Carefully dress the extractor ring starting bevel corners, as needed, for extractor installation, but do not undersize the bevels or the flat key surfaces.

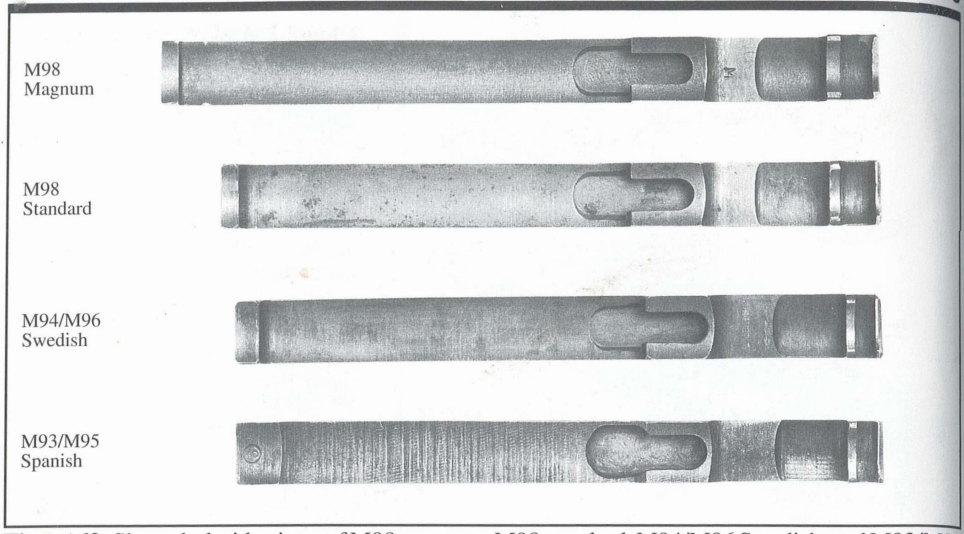


Figure 62- Shows bolt side views of M98 magnum, M98 standard, M94/M96 Swedish, and M93/M95 Spanish type extractors. Closely inspect the thin bolt lug clearance area just behind the extractor guide foot for stress cracks. The bevelled guide foot (on M98 extractors only) must be unaltered and capable of maintaining engagement in the bevelled guide slot in an M98 bolt during extraction. The extractor ring key slot must be clean, in original factory condition, and capable of fully engaging both extractor ring keys. Sharp inside extractor edges on either side of the keyway cut should be deburred to prevent drag or contact marking the bolt body. Contact surfaces at the bottom of the guide foot and the extractor tail should be deburred for smooth travel.

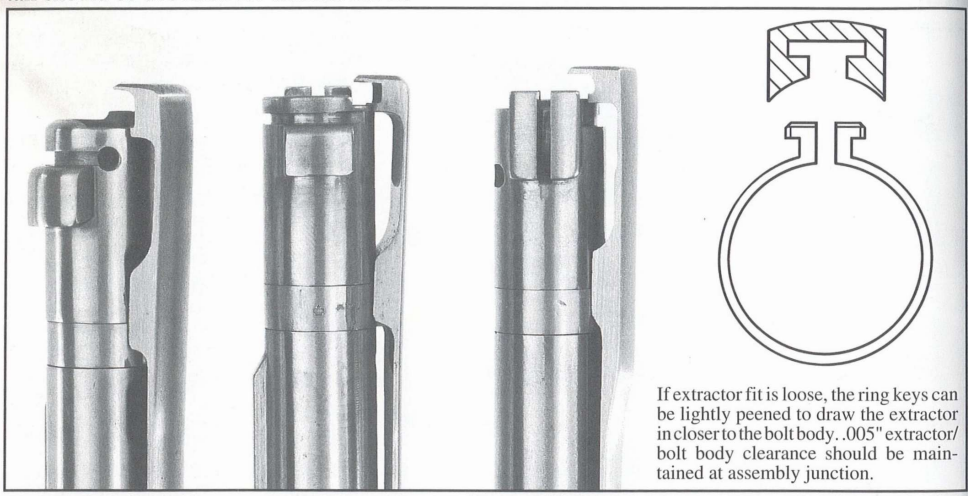


Figure 63- Shows an M98 type claw extractor being installed, at left. The extractor ring is compressed into the bolt's ring recess as the extractor's keyway is started onto the extractor ring keys. The extractor is then pushed down until the extractor guide lines up with the guide slot in the bolt body. M94/M96 Swedish type extractors line up with the flat clearance cut in the side of the bolt and start in the same way. Square bottom bolt M93 Spanish extractors, at right, install by lining up the extractor ring keys with the guide clearance recess at the front of the bolt, and then starting the extractor onto the keys and pushing it in until its guide also lines up with the guide slot in the bolt. Late round bottom M95 and nonSwedish M94 extractors install in the same way as the M94/M96 Swedish. With all three extractor types, once the guides are lined up with the bolt guide slots, assembly is completed by applying thumb pressure at the ring assembly junction and then rotating the extractor until the guide drops into the bolt's guide slot. Use extractor pliers when extractor tension and fit do not permit installation by hand.

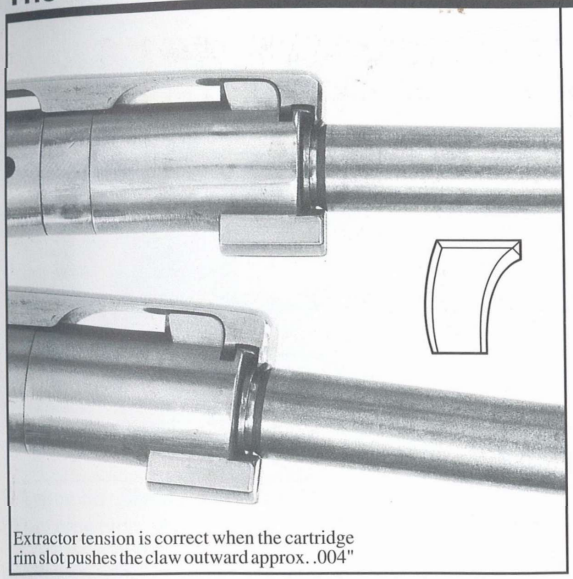


Figure 64- Shows M96 and M95 extractors engaged on cartridge rims. The front extractor bevel, see illustration below, cams the claw to the side to allow the extractor to climb over a chambered cartridge rim. The single shortcoming of the M93~M96 extractor design is that the claw can deflect and fail to extract an expanded cartridge case.

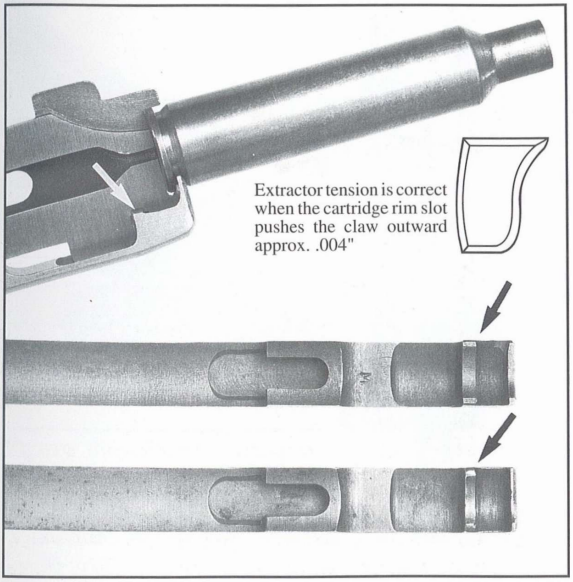


Figure 65- Shows an M98 claw extractor on a cutaway M98 bolt engaging a cartridge. During extraction, the M98 extractor guide foot is mechanically retained by the bevelled guide slot in the bolt, see arrows above. The foot disengages the bevel when the extractor is pushed back. M98 extractors also cam to the side to engage a chambered cartridge.

About M92~M96 Extractor Fit-

Although there are slight dimensional differences between the M92~M96 extractors, function and checkout are the same.
The following fitting rules apply:
1. The extractor claw must be long enough to ride the bottom of the cartridge rim slot.
2. The extractor claw should allow the cartridge rim to slide about halfway into the bolt face recess before beginning to exert spring pressure on the cartridge rim slot. Fit is correct when a fully engaged cartridge rim pushes the claw out approx. .004".
3. The cam surface at the front of the claw must remain at the original factory 45° angle and contour in order to cam the extractor over the rim of a chambered cartridge.
4. The claw at the front of the extractor should be as thick as possible, but not so thick that the end of the claw hits or pushes against the rear barrel face as the bolt is closed.
5. To minimize claw deflection during extraction, the extractor ring key and extractor keyway fit must be tight enough to keep the extractor against the bolt body.
6. Extractor fit must not be so tight that the extractor drags on or gouges the bolt body.
7. The extractor must not be so high (vertical dimension) that it drags inside the receiver.

About M98 Extractor Fit-

The above fitting rules also apply to M98 type extractors. See figure 65. The extractor's guide bevel (M98's only) must maintain positive engagement inside the bolt's bevelled extractor guide slot during extraction.
1. Test engagement by installing a dummy cartridge, pulling the claw forward, and trying to push the claw away from the bolt body.
2. Then, move the extractor to the rear until it stops. Push the extractor sideways with the rim of a dummy cartridge. With bevelled guide disconnected, the extractor claw should deflect just enough to climb over the rim of a chambered cartridge.

Install M91 Hook Extractor

1. Detail clean and inspect the M91 hook type extractor. If altered, pitted, chipped, cracked, or otherwise dam-aged, replace the extractor.
2. If not already done, detail clean the bolt's extractor keyway slot and extractor retaining stud recess, at this time. See detail in figure 28.
3. Lubricate the extractor and extractor keyway slot with light grease to prevent corrosion. Start the extractor into the keyway in the bolt body. See figure 66.
4. Lightly tap the extractor into final position on a wooden bench block until the extractor retaining stud bevel climbs over the bolt face and snaps into the extractor stud locking recess in the bolt body. See figure 67.
5. Check extractor tension by pushing in a dummy cartridge. The extractor should deflect and return with sufficient hook engagement and spring tension to hold the cartridge rim inside the bolt face recess.

Bolt Safety & Common Sense

With previous bolt inspection and fitting steps done, pre-liminary bolt body and parts inspections are complete at this time. However, even if the action, or barrelled action, appeared to be in serviceable condition before disassembly, the bolt assembly can't be considered ready or qualified for use. In the case of a barrelled action, do not reinstall the bolt in its parent receiver until barrel condition, chamber condition, and headspace have all been checked and the barrelled action has been determined to be safe for test firing.

Caution: Bolt and receiver lugs must not be lapped at this time unless the barrel is to be requalified or replaced and the chamber adjusted to correct headspace.

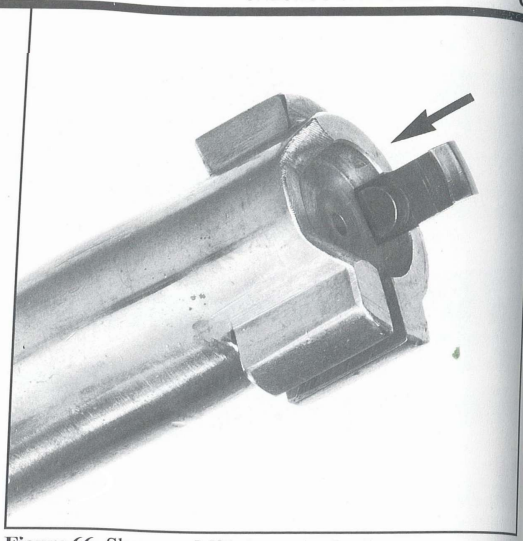


Figure 66- Shows an M91 Argentine hook extractor started into the extractor keyway in an M91 bolt. M91 Spanish extractors are similar. Do not attempt to acid clean leaf springs, particularly extractors. Clean slightly rusty surfaces, instead, with a fine wire brush. Lubricate M91 extractors and bolt keyway slots with light grease before assembling.



Figure 67- Shows an M91 hook extractor being seated in the extractor keyway in an M91 bolt body. Once the extractor has been pushed in as far as it will go, tap it into final position on a wooden bench block. M91 extractors lock in place as the installation bevel at the back of the extractor retaining stud climbs over the corner of the bolt face and drops into the retaining recess inside the extractor slot.

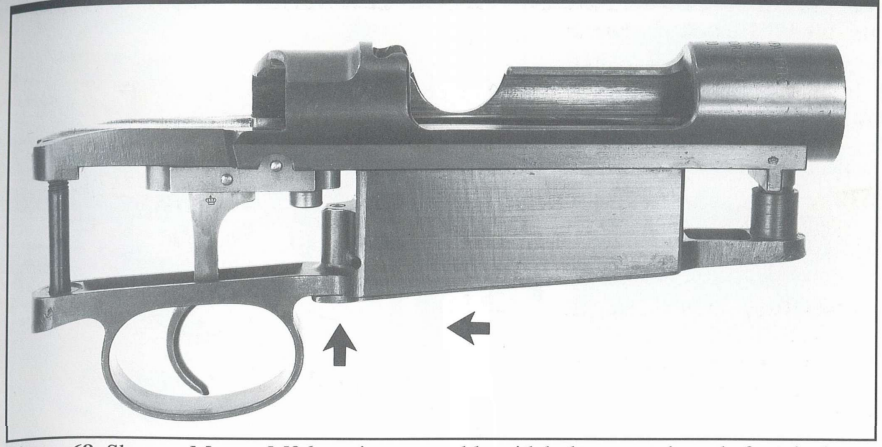


Figure 68- Shows a Mauser M96 receiver assembly with bolt removed, ready for takedown. The receiver, above, is shown without stock for greater visibility. The magazine floorplate, magazine follower, and follower spring are removed from standard M93~M98 military models by depressing the floorplate release plunger, see arrows above, and pushing the floorplate back toward the trigger guard until the floorplate catch disengages. The floorplate/follower assembly can then be removed from the magazine well. Hinged Oberndorf type commercial sporter floorplates can be removed from the magazine housing by punching out the floorplate hinge pin.

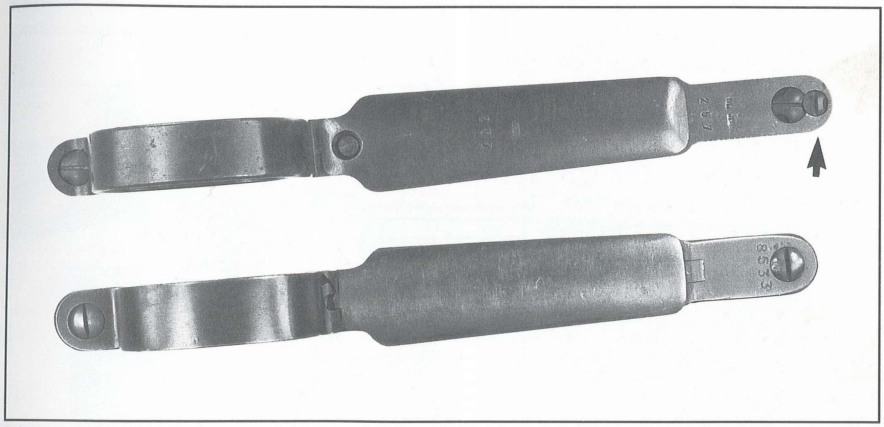


Figure 69- Shows bottom views of a Mauser M98K trigger guard/magazine housing assembly, at top, and an M93 Spanish short rifle assembly, at bottom. The M98K assembly has small lock screws that retain the main receiver mounting screws. Other mounting screw head styles and front lock screw positions are found on M98 actions made on contract for world governments. The M93 short rifle trigger guard/magazine housing assembly shown has a hinged floorplate. Most specimens do not have lock screws. Many M93 Spanish standard rifles and M95 carbine actions have lock screws with the front lock screw positioned to the rear. **Caution**: Always use correctly sized hollow ground screwdrivers to prevent screw slot damage when removing lock screws and receiver mounting screws. If a screw is stuck or resistant, immerse assembly in penetrant. Help break screw head or thread bonding by impacting the screwdriver handle with a plastic hammer and pushing down before turning.

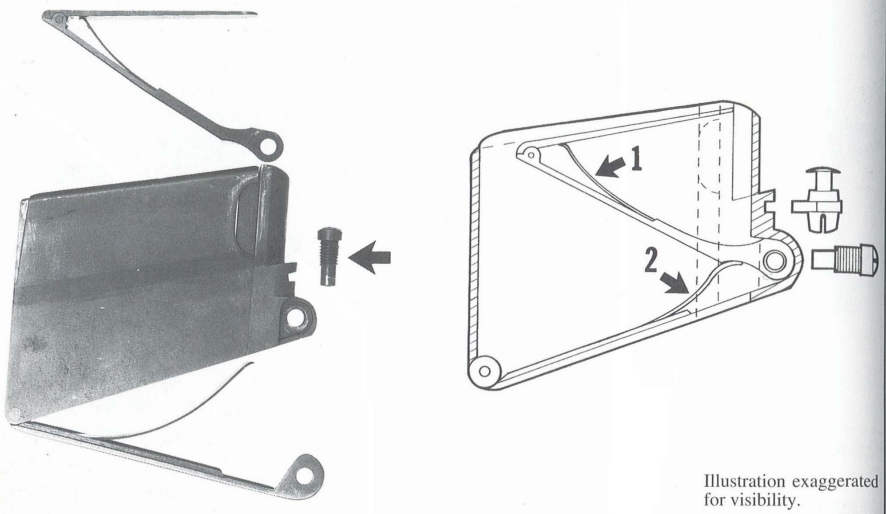


Figure 70- Shows a Mauser M91 type magazine, at left, with floorplate and follower assemblies removed for cleaning and inspection. Partially backing out the magazine assembly screw releases the hinged, single row M91 type floorplate assembly. Removing the assembly screw permits removal of the magazine follower assembly from the top of the magazine box. Weak upper or lower magazine springs, shown at 1 and 2 in the illustration at right, should be replaced. If the magazine box and internal parts are in serviceable condition, lightly oil, reassemble, and place the magazine in the parts box for later installation. M91 type trigger guard/magazine retainer plates are removed by unthreading the receiver mounting screws.

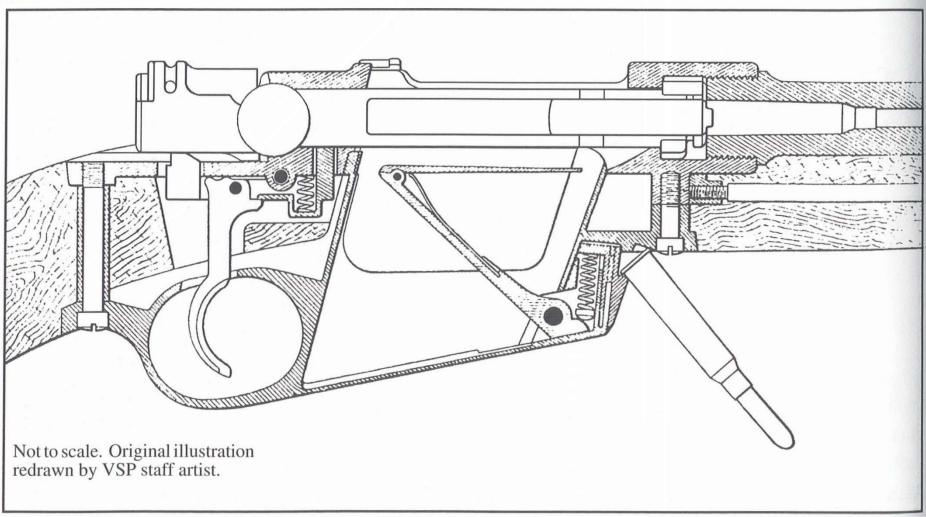


Figure 71- Illustration shows an M92 type magazine floorplate and follower assembly ready for removal. The floorplate catch is disconnected by prying down on the front of the magazine with a .473" diameter cartridge rim, as shown above. Once disconnected, the magazine floorplate/follower assembly drops away from the magazine well. M92 type trigger guard/magazine housings are removed by unthreading the two receiver mounting screws.

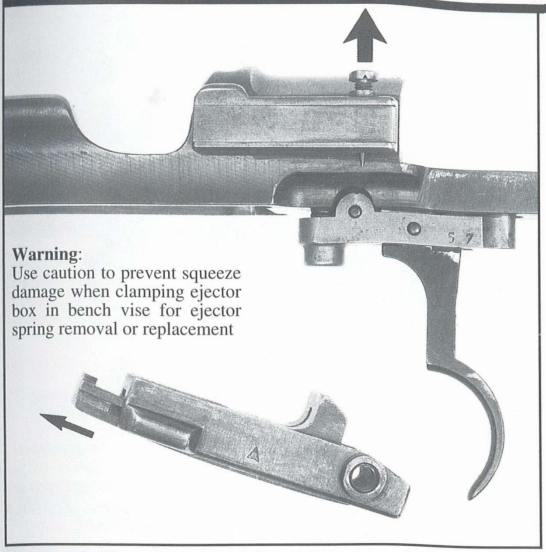


Figure 72- Shows an ejector box pivot screw being removed from an M98 receiver. M93~M98 ejector boxes are removed by unthreading and pulling out the ejector box pivot screw. If spring replacement or internal cleaning is needed, the ejector spring can be removed by clamping the box between soft vise jaws and tapping the spring forward with a brass drift.



Figure 73- Shows an M91 ejector box. The ejector box screw, see arrow at top, is unthreaded to remove the ejector box spring. The M91 ejector spring inside is removed, in the direction shown below, with a brass drift. The ejector box and ejector arm are then removed from the receiver by pushing out the ejector box pivot pin with a 1/16" punch.

Remove M93~M98 Type Ejector Box Assembly

Remove ejector box as follows:

1. Unthread and pull out the ejector box pivot screw.
2. Remove the ejector box assembly from the receiver and soak in cleaning solvent.
3. If the ejector box is impacted with dirt and dried oil, clamp the box assembly in a vise between soft vise jaw pads.
4. Carefully tap the ejector box spring forward and off the ejector box with a small brass drift.

Caution: Do not oversqueeze and damage the ejector box. If the ejector box spring is resistant and causes the box to slide forward between the soft jaw pads, recess the jaws slightly to limit forward movement.

5. Detail clean the parts with solvent and a bristle brush.
6. Inspect the ejector box housing, spring, and ejector arm. Replace parts that are excessively worn, pitted, or damaged. If parts condition or correctness is questionable, compare against serviceable replacement parts.
7. Lightly oil, reassemble, and place assembly in parts box.

Remove M91 Ejector Box Assy.

1. Unthread the ejector box spring retaining screw.
2. Drift the ejector box spring (outside) forward off the box with an 1/8" brass drift placed in the screw counterbore.
3. Then, drift the ejector spring (inside) forward and out of its slot with an 1/8" brass drift.
4. Push the ejector box pivot pin out from below and remove the ejector arm. See figure 73.
5. Detail clean parts with solvent and a bristle brush.
6. Inspect ejector box and parts. Replace if excessively worn, pitted, or damaged.
7. Lightly oil the ejector box and parts, reassemble, and place in the parts box.

Remove M92-M98 Military Type Trigger Assembly

Mauser M92~M98 military actions use triggers of basically similar design. M91 triggers are somewhat different. See fig. 75. Remove M92~M98 triggers as follows:

1. Apply drops of penetrating oil at both ends of the sear pivot pin and the receiver's sear pivot stud to help loosen tight pivot pins.
2. Inspect both ends of the sear pivot pin for staking, peening, and/or end expansion.
3. Drive the sear pivot pin out from the least expanded side with a tapered .090"-.100" drift.
4. Use care to prevent loss of the sear spring and pivot pin. See figure 74. Catch the sear spring with fingers as the drift is withdrawn.
5. Clean and inspect trigger assembly parts at this time, only. Note the condition of the trigger and sear operating surfaces. The trigger pivot pin need not be drifted out unless the sear or trigger appear worn, altered, and/or damaged. The trigger and the sear are function checked on reassembly. See page 90.

Remove M91 Type Trigger

M91 type trigger assemblies are removed in the same way as the later M92~M98 triggers, discussed above. However, extra care is needed to avoid damaging the M91 receiver's longer sear pivot extension. See figure 75.

About Sporter and Custom Adjustable Triggers

Adjustable custom accessory and sporter trigger assemblies are retained on receivers with a standard, military type sear pivot pin. Most of these triggers also have an installation/tightening screw which must be backed out before attempting to drift out the sear pivot pin.

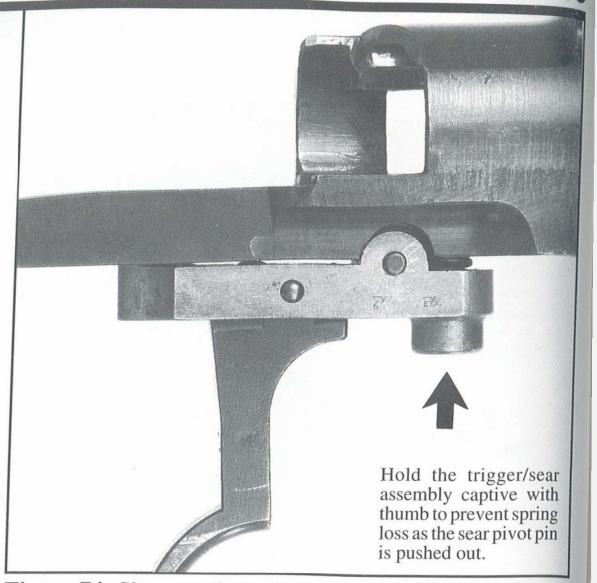


Figure 74- Shows a close view of a standard M98 military type trigger/sear assembly and sear and trigger pivot pins. The sear pivot pin must be drifted out to remove the trigger assembly from the receiver. The sear pivot pin is sometimes peened and expanded more on one side than the other. The pin must be drifted out from the least expanded side.

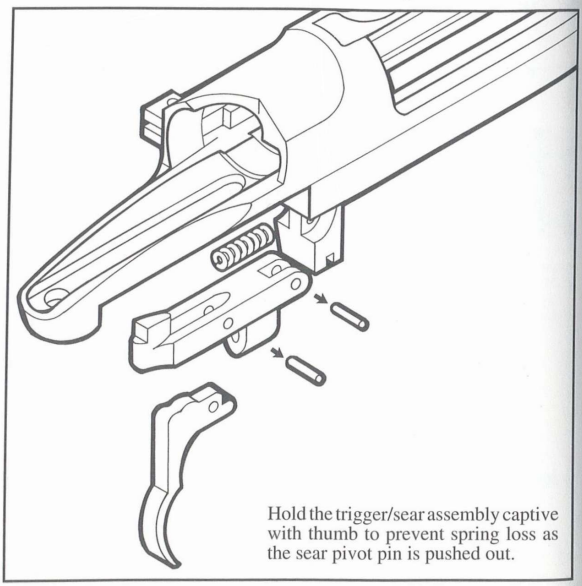
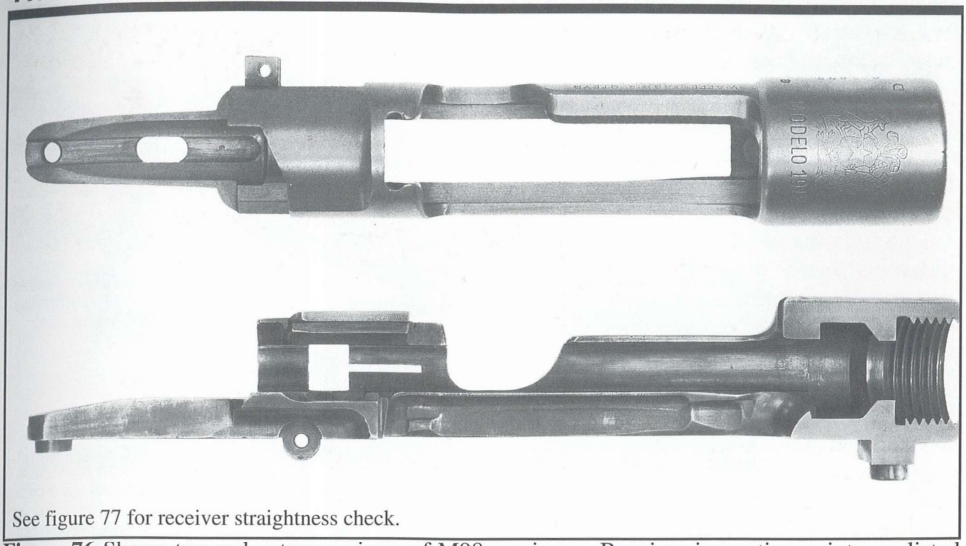


Figure 75- Illustration shows a Mauser M91 trigger/sear assembly, and sear and trigger pivot pins. M91 pivot pins are also typically peened and expanded on one end. Trying to drive the expanded end of the pin through the sear body can damage both the sear and the receiver's fragile sear pivot extension. Drift pivot pins out from the opposite side.



See figure 77 for receiver straightness check.

Figure 76-Shows top and cutaway views of M98 receivers. Receiver inspection points are listed below. M98 barrels torque on the shoulder at the front of the reinforcing web inside the receiver ring. M91~M96 barrels torque only on the front of the receiver ring. M98 receivers have a third safety lug between the bolt guide rails under the rear receiver bridge. M92 through M96 Mauser receivers have a trigger/sear/bolt safety interlock port in approximately the same position as the M98 3rd lug, otherwise Mauser M91 through M98 receiver inspection points are basically the same. Most of the inspections listed can be made with the barrel installed. Whether or not the barrel should be removed at this time would depend on barrel condition, headspace, overall rifle condition, and work to be done.

1. **Receiver bolt lug engagement surfaces**- must not be galled, pitted, or more than lightly wear seated. Check engagement surfaces with a small mirror and a flexible light. If more than light lug surface wear is found, remove the barrel for a detailed lug area inspection. See figures 78 and 79 and barrel removal in Sect. II.
2. **Cartridge ramp**- this surface must not be altered. Metal removal weakens the lug- only light polishing is suggested. The ramp in the cutaway receiver has been altered.
3. **Front ring**- must be round. If compressed or oval, the bolt may drag in the receiver.
4. **Front ring**- check for cracks through the extractor slot on the right side. Receiver cracks of this type are typically caused by reheat treating or installing barrels with oversized threads.
5. **Receiver barrel threads**- must be in serviceable condition.
6. **Receiver screw threads**- (.250"-22) must be in serviceable condition.
7. **Sear pivot stud and pivot pin hole**- must be in original condition.
8. **Ejector box mounting studs**- must be in original condition and capable of holding the ejector box tight to the receiver and without wobble.
9. **Safety lug (3rd lug, M98s only)**- must be in original condition. The bolt safety lug would not make contact with this surface unless the bolt had been set back by extreme overpressure.
10. **Sear slot**- must not be altered or damaged.
11. **Trigger/sear/bolt safety interlock port (M92~M96 only)**- must not be altered or damaged.
12. **Bolt ways/magazine rails**- must permit smooth bolt travel. Rails must not be open more than required for smooth cartridge feeding.
13. **Receiver internal barrel torque shoulder (M98's only)**- must be unaltered, smooth, and at 90° to receiver centerline.
14. **Receiver/barrel torque shoulder (M91~M96)**- must be smooth and at 90° to receiver centerline.

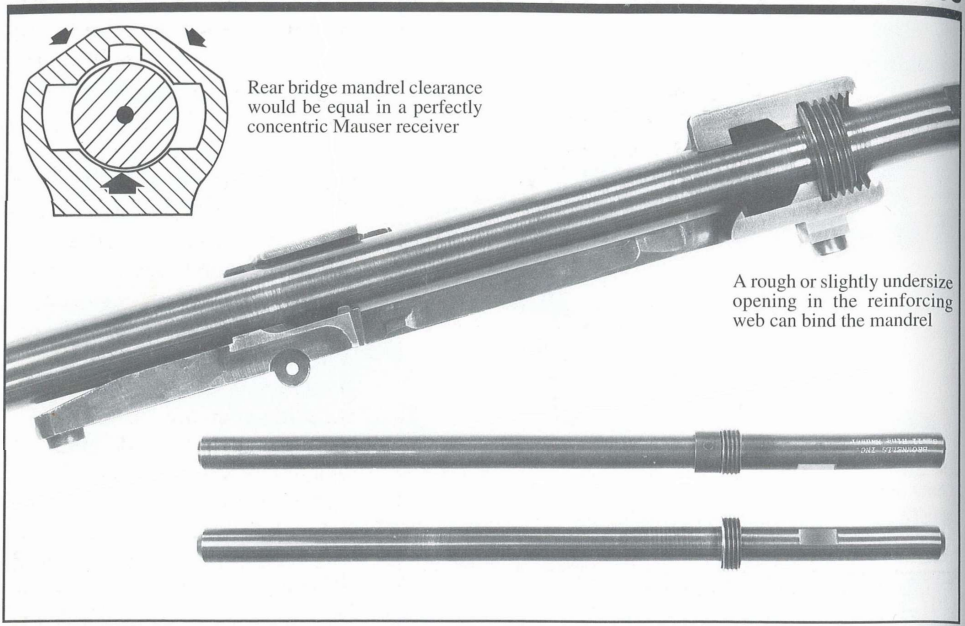


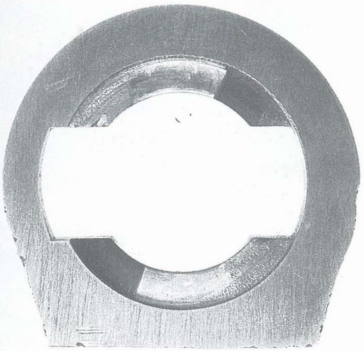
Figure 77- Shows a cutaway M98 receiver with a large ring receiver mandrel (1.10" thread dia.) installed and hand tightened. Large ring (1.10" thread dia.) and small ring (.980" thread dia.) receiver mandrels are shown below. Both mandrels have approx. .700" diameter shanks. Using a receiver mandrel as a concentricity gauge, as shown and illustrated above, is a quick and easy way to check Mauser receivers for basic straightness. Because concentricity is more accurately gauged with the threaded mandrel shank tightened to a 90° surface inside the receiver, the barrel, trigger/sear assembly, and ejector assembly must be removed before testing, as shown above. A less accurate alternative for barrelled receivers, because receiver threads are not taken into consideration, is to comparison check the flat bottom of the receiver against a trued steel block.

Ideally, in a perfectly concentric action, barrel, receiver, and bolt centerlines would agree; locking lugs would engage uniformly; the bolt body and firing pin would be on exact center, and there would be no receiver related cause of bolt drag. However, the manufacturing/heat treating process invariably warps all bolt action receivers to some extent. The amount is usually small and increases typically with action length. The odds on finding a perfectly concentric bolt action receiver made by any manufacturer would be quite small. For this reason, Mauser M91 through M98 bolt lug ways and bolt guide surfaces are machined slightly oversize to compensate for slight warpage and to eliminate possible bolt bind.

The cross sectional illustration, above, shows a receiver mandrel as it would pass through the round bolt guide area inside the rear receiver bridge in a concentric receiver. Clearance would run about .005"-.006" at each of the three bolt guide points shown. However, mandrel weight and thread clearance usually causes the mandrel and shank to rest on the bottom bolt guide surfaces, as if on vee blocks. With the mandrel on the bottom guide surfaces, typical mandrel shank/top bolt guide clearance would be double, or about .010"-.012". Mauser receivers are considered sufficiently straight if the mandrel can be screwed in all the way without binding. If clearance at the two upper rear bridge points shown in the illustration is equal, so much the better.

If the mandrel drags or binds at the top, bottom, or on one side of the receiver, and the contact area is not rough or burred, the receiver is probably not concentric. To verify, check the flat bottom of the receiver for full contact against a gauge surface. A workable gauge can be made by fly cutting and truing one side of a rectangular steel block. A nicked, rough, or slightly undersize opening in the reinforcing web in an M98 receiver can bind the mandrel. To avoid this, the web opening should be trued and lightly polished before mandrel installation.

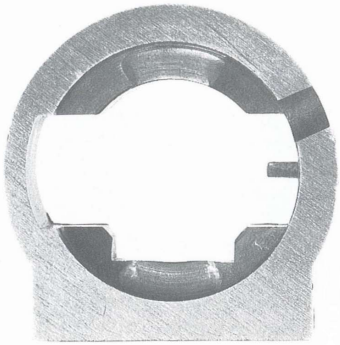
Basically, this check determines whether the receiver is concentric enough to be considered serviceable. Receivers that can't pass this test should not be used. Further use of receiver mandrels is discussed in section II. - Receiver mandrels are available from **Brownells, Inc**.



Suggested receiver lug area wear seating limit is .002"
There are three basic reasons for this:

1. Seating that is much deeper can be hard to hand lap out.
2. Resurfacing may cut through a thin case hardening layer.
3. Impressions that are deeper may indicate the receiver is soft.

Figure 78- Shows an M98 receiver that has been sectioned to expose the bolt lug engagement area. Both lug bearing surfaces were serviceable, although the top lug area shows moderate wear seating, probably caused by bolt/receiver tolerance accumulation and wear-in. Receiver lug area wear seating should not exceed a depth of .002".



Barrels must be removed when detailed receiver lug area inspection is required.

Figure 79- Shows a sectioned M93 Spanish receiver that had been rebarrelled and chambered to fire the 7.62mm CETME cartridge (M1916 conversion). Receiver lug surfaces are set back .009". This low carbon steel receiver is extremely soft and has been pressure abused. Whether the above lug setback was caused by firing CETME or 7.62 mm NATO (.308 Winchester) cartridges is unknown.

About Mauser Receiver Lug Area Wear Seating & Setback-

Exact specifications and limits for Mauser M91~M98 receiver lug area wear seating and lug area setback have not been available. To solve this problem, some gunsmiths have adopted a practical approach, based on visual inspection, to select M98 receivers that are serviceable and suitable for rebarrelling. This approach involves examining the receiver bolt lug bearing areas for surface pitting, damage, alteration, apparent wear seating, and receiver lug setback. As a safety margin, M91~M96 receivers and actions are not used. The receiver bolt lug bearing surfaces are considered serviceable and the receiver suitable for rebarrelling if the lug bearing surfaces are unpitted, show only light wear polishing from bolt lug contact, and wear seating measures .002" deep, or less. Receivers with lug areas that are altered, pitted, damaged, galled, wavy, or show evidence of lug surface setback (to include wear seating greater than .002"), are considered unserviceable and are not rebarrelled.

Gunsmiths who suggest this method state that, if the receiver lug surfaces show only shiny wear polishing after years of service, receiver lug case hardening thickness and core hardness underneath is probably fine. Because the lug areas would be visibly set back, many soft and most pressure abused receivers would be detected in this way. The failing of this approach, as I see it, is that both too hard and moderately soft receivers would not be detected. See "About Mauser Receiver Hardness" on pages 70 and 71.

About Mauser Receiver Hardness-

Steel samples from various M91~M96 receivers I have had tested appear to be roughly equivalent to U.S. low carbon 1020, 1025, and 1030 steels. One Spanish made receiver analyzed below 1020. M98 receivers that were tested appear to be the equivalent of 1035 and 1036 steels. Receivers made from 1035, or equivalent steel, and heat treated to a hardness of about 33C to 35C, for example, tend to be quite tough under normal operating pressures, but reasonably soft in the core under the case hardening layer. A receiver heat treated in this way would stretch or permit lug setback if subjected to excessive pressures. Lug area setback can occur in harder Mauser receivers if pressure abused and/or when excessive headspace is present. Keep in mind that a stretched receiver or a receiver with lug setback is a far sight better than a cracked or shattered receiver.

Early production (pre-1936) M98 Mauser receivers were not carburized as well as later production. See figure 82.

Case hardening thickness in Mauser receivers I have sectioned has varied from a few thousandths to beyond .035" in one excessively reheat treated receiver. Case thickness, in most cases, ranged from .002" to .008".

As I see it, representative hardness testing is useful for detecting a soft receiver as well as the rare over carburized and excessively hard receiver. With soft receivers, the thin case hardening layer yields; as a result, only core hardness is measured. However, hardnesses of about C18 or less often do not read. If testing indicates a receiver is overly hard at some exterior point, consider that the rest of the core probably is too. These receivers should be checked and redrawn by a qualified heat treating firm or tagged as unserviceable.

Low carbon steel has a built in safety margin in that it is core hardenable only to a limited extent. Over carburizing can cancel out this safety factor.

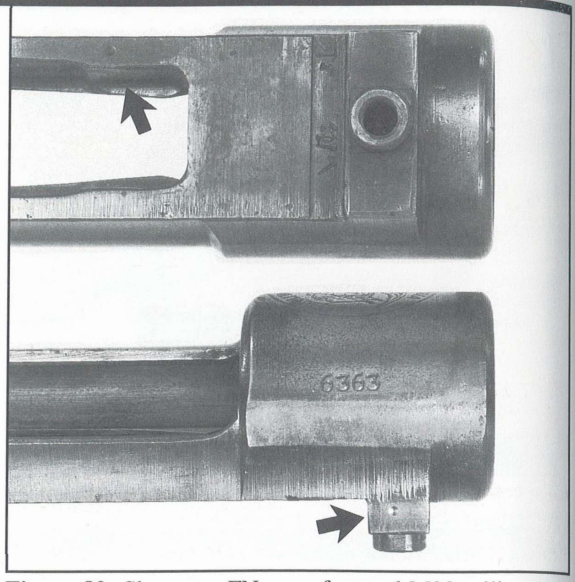


Figure 80- Shows an FN manufactured M98 military receiver. Representative factory hardness test indentations are located at the side of the recoil lug and on the flat bottom of the receiver behind the feed ramp, see arrows. FN receivers were tested, as shown, because the lug engagement surfaces inside the receiver can't be machine tested directly.

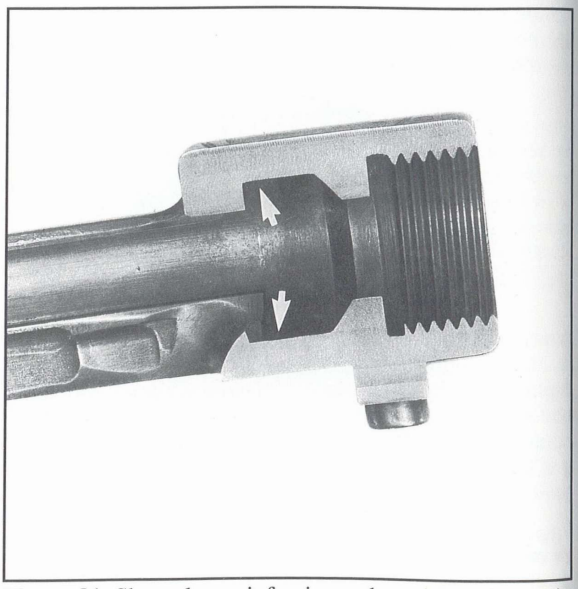


Figure 81- Shows lug, reinforcing web, and thread areas in a half-sectioned M98 receiver. Although the receiver lug area can't be directly hardness tested, nearby surfaces, see arrows above, can be checked for a thin case hardening layer by scraping with a sharp awl or pocket knife. If the surface can be easily penetrated and scraped, the case hardening layer can be considered to be too thin.

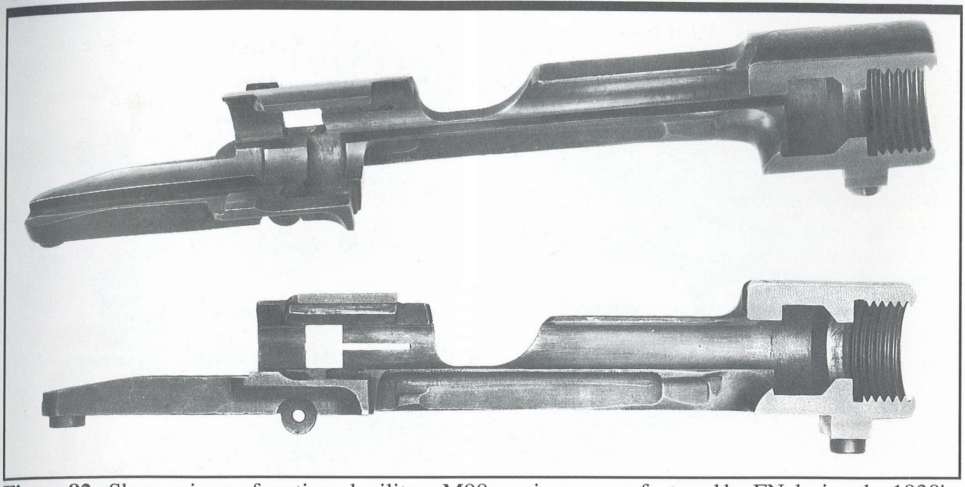


Figure 82- Shows views of sectioned military M98 receivers manufactured by FN during the 1930's. Case hardening thickness was relatively thin, ranging from .002" to .005" on the above specimens. Representative hardness readings were C25 and C26 on exteriors and C18 to C20 in the interior core areas that were tested. Results of alloy analysis by emission spectrograph of several random specimens of this type receiver indicated carbon contents of .327 to .321; manganese content of 1.47 to 1.52; copper content of .059 to .062; phosphorus content of .015 to .016, and sulphur content of .035 to .037. The carbon content is most important in this discussion because it determines the basic hardenability of the steel. The low phosphorous and moderate manganese and copper contents permitted easier machining in the manufacturing process. Hardness readings of about C25 are fairly common in FN made M98 receivers. Some FN receivers manufactured in the early 1950's are somewhat softer.

M98 receivers made by Mauser's European affiliates before 1936 (FN is a separate case, as discussed above) are usually not as well heat treated as most that were manufactured thereafter. Case thickness in M98 receivers made from 1936 on varies considerably, but in the best specimens, averages approx. .008" to .010". Thicknesses of .012" to .016" are occasionally found. While heat treat in most of these receivers is generally consistent and sufficient for use, case thickness and hardness readings in some vary considerably. I suggest having all Mauser bolts, receivers, and cocking pieces hardness checked and reheat treated, if necessary, as a part of rebuilding actions and before barrel installation and use when restoring Mauser military rifles that are to be fired. The same would hold true when building custom sporting rifles on Mauser actions. Use only heat treating firms fully familiar with firearms heat treating requirements and Mauser actions in particular. One of the best, at the time of writing, is:

Blanchard Metal Processing
1115 So. Pioneer Road
Salt Lake City, UT 84125

Steels containing 0.30% to 0.33% carbon tend to heat treat and reheat treat predictably when processed under precisely controlled conditions. Accurate calibration of hardness testing equipment and critical control of oven and processing temperatures is absolutely important in heat treating. Although opinions vary, ideal case thickness in an M98 receiver is .010" to .015". This is enough to harden the bearing surfaces, such as the receiver lugs, and to create a strengthened exterior case.

Typical reheat treating procedure is:
1. Place shallow .010"-.015" case on parts in gas furnace.
2. Oil quench.
3. Check hardness. Typical exterior test range is C35 to C40. Corresponding internal core hardness will vary, usually between 22C and 30C.
4. Adjust hardness by reheating in oven, usually to about 890°F, and then air cooling.

Note: Different hardness readings require different drawing temperatures.

Bolt and handle work and receiver work, including drilling and tapping the receiver for sights and polishing, is done before sending parts in for heat treating.

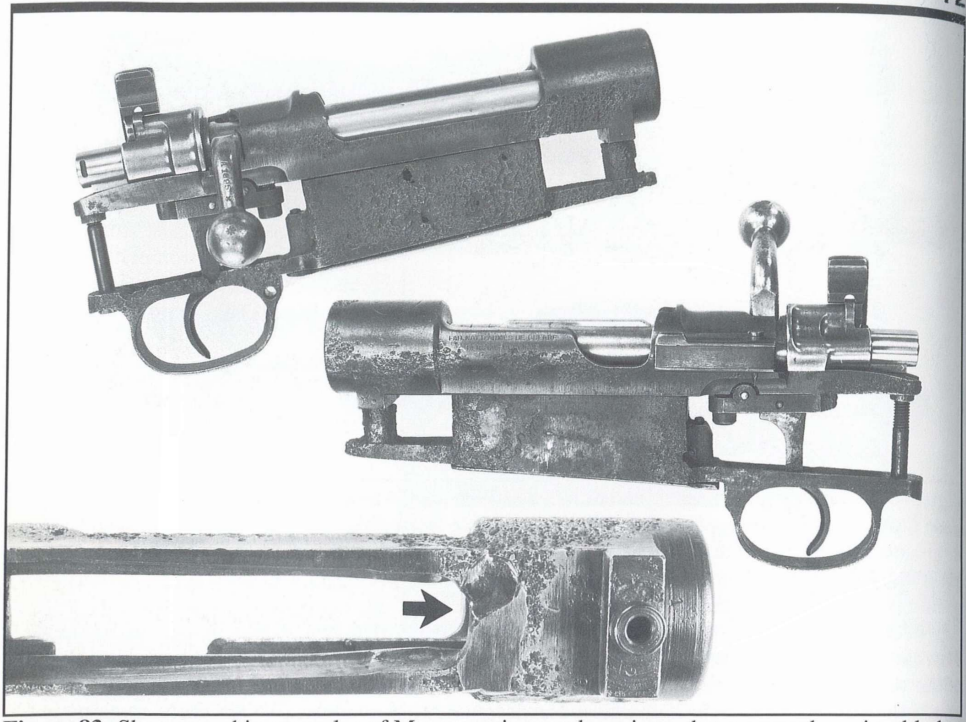


Figure 83- Shows graphic examples of Mauser actions and receivers that appeared serviceable but were found to be heavily pitted and unserviceable when removed from stocks. The Mauser M98 Standard Modell (German spelling) action, at top, is heavily pitted below the stock line on both sides. Several of the larger pits in the front ring immediately outside the extractor slot run more than .075" deep, or about halfway through the right receiver wall.

The FN M98 action, at center, is heavily pitted on the left side. Some of the deepest pits are in line with the thinnest part of the left receiver wall. When picked out with an awl, two of the pits were found to run more than halfway through the receiver. This receiver was also heavily pitted where the hand guard contacted the front ring. The receiver, at bottom, has been arc welded in an attempt to repair probably severe metal damage at the feed ramp. Welding receivers over barrel threads, near lug engagement areas, and/or over rust pits, is not recommended for the following reasons:

1. Welding heat warps the front ring, to greater or lesser degree, and affects heat treat, particluarly in the lug engagement and receiver thread areas.
2. Even when welding is done professionally and at the lowest possible temperatures, receivers must be annealed and reheat treated.
3. Welding edges are usually visible after oxide bluing.
4. Welding to cosmetically repair rust pit damage, even when pits seem perfectly clean, almost always leaves foreign material behind which creates voids and oxide pockets in welds.
5. Although there are exceptions to the above, replacing a receiver rather than welding on it is simpler and cheaper.

The front ramp area in the M98 receiver, at bottom, was welded and resurfaced on top and appeared original when the action was in the stock. Although the front ring appeared normal except for pitting damage, it was warped in the bottom lug area from welding heat.

With the above examples in mind, make it a practice to remove every barrelled action assembly from its stock and closely inspect all surfaces for pitting and other damage before headspacing and test firing. I also suggest that receivers be examined for any evidence of welding or concealed metal repairs. Weld bead edges are nearly always visible after hot oxide bluing, but are usually harder to spot in receivers that have been rust blued.

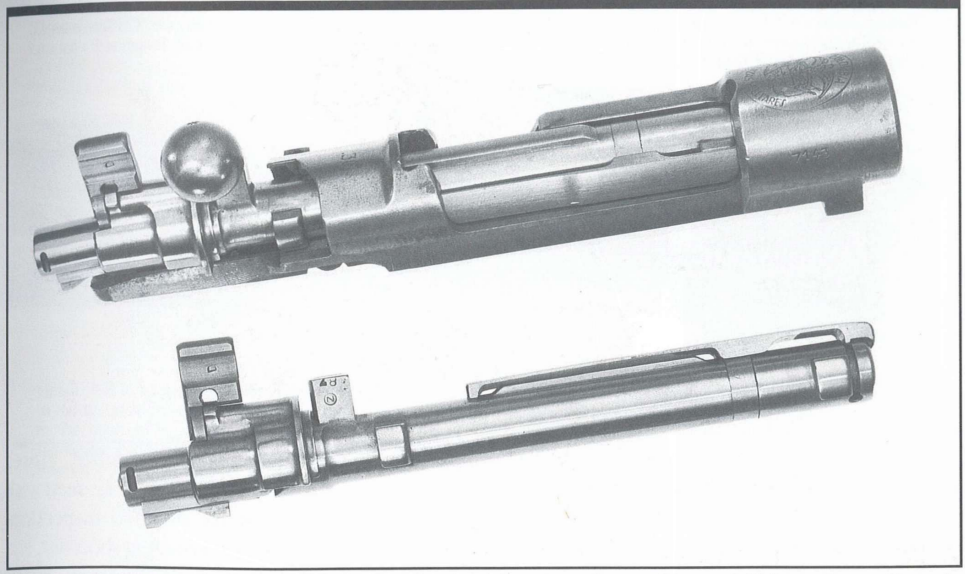


Figure 84- Shows a bolt assembly being checked for smooth travel in an M98 receiver. Even in concentric receivers (see figure 77), bolt drag can be caused by loose extractor/extractor ring fit; a rough bolt body; a bent, bowed, thick, or rough extractor; a tall, misfit, or rough magazine follower; a bent or damaged ejector arm; a rough or nicked receiver cocking piece guide slot; a long rear receiver mounting screw; nicked or bent magazine rails; nicked, burred, or rough receiver bolt guide surfaces; and/or nicked, burred, or rough receiver bolt lug guideways. Bolt drag in M92 through M96 receivers also can be caused by a rough or slightly tall trigger/sear/bolt safety interlock stud.

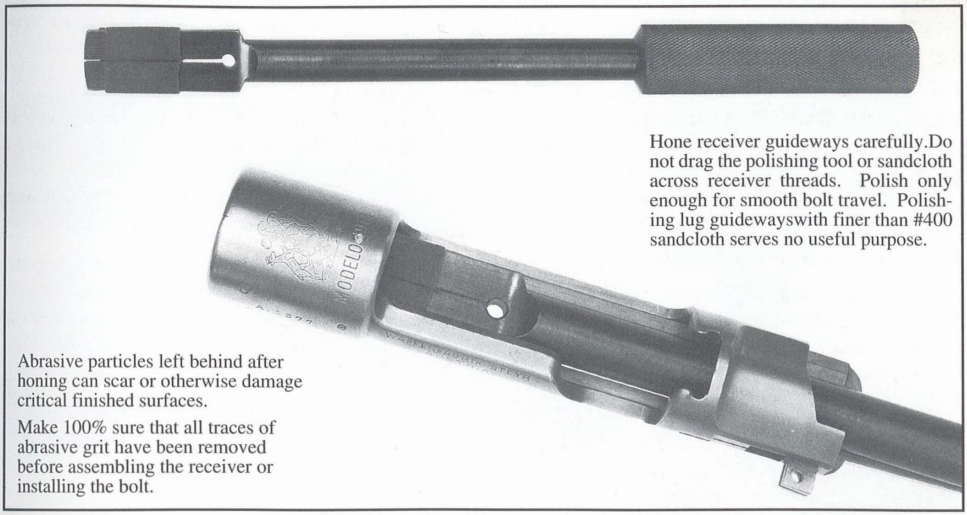


Figure 85- Shows bolt lug guideways in a stripped M98 receiver being honed with a receiver guideway polishing tool. The guideway polishing tool, available from **Brownell's, Inc.**, is shown separately, above. Lightly stone and remove rough or nicked edges at the guideway entry at the rear of the receiver and chamfer sharp edges lightly before honing. If needed, use Dykem blue to locate high spots and rough areas. Before honing, degrease and dry the receiver to prevent accumulation of sanding grit. Then, hone the bolt lug guideways with #320, followed by #400 sandcloth. Hone first one side then the other until guideways are smooth. For best results, clean sandcloth and keep wet with kerosene or safety solvent.

Chambers and bores that appear serviceable in barrels that have been fired regularly quite probably are. Critical internal dimensions, however, can't be measured by eye. All bores, chambers, and throats should be fully inspected, cast and measured, before test firing or use.

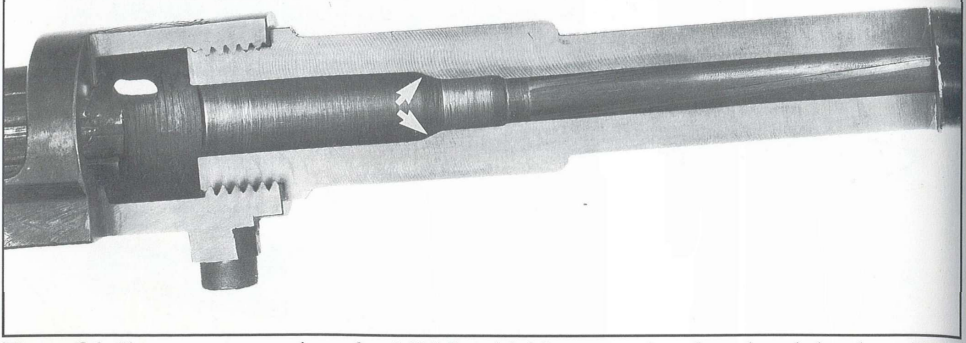
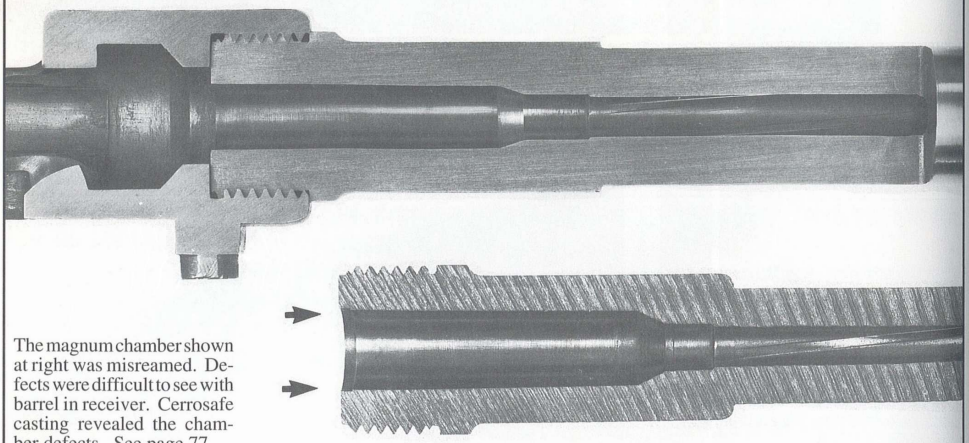


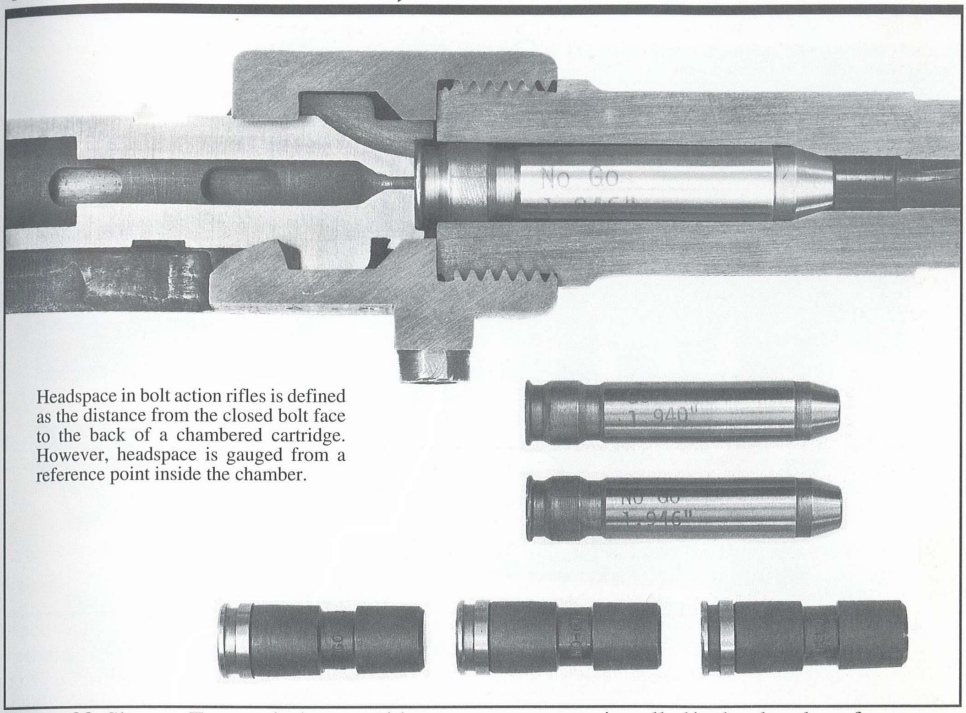
Figure 86- Shows a cutaway view of an M95 Spanish Mauser receiver, barrel, and chamber. Bores and chambers that appeared to be in serviceable condition, on initial inspection, are detail cleaned with powder solvent and bore/chamber brushes, at this time, in preparation for detailed inspection, headspace checking, and chamber casting. Rimless cartridges headspace on the chamber shoulder, see arrows, above. For this reason, chambers and chamber shoulders must be completely clean. Dried lubricant, dirt, and other residue must be removed before headspace checking, as shown in figure 88. The chamber and throat shown above are poorly reamed. Otherwise serviceable barrels can be requalified in cases where barrel setback and chamber reaming will clean up a small chamber defect. Barrels with chambers that will not clean up or with bores that are worn, altered, pitted, scratched, bent, or otherwise damaged, must be replaced. See barrel inspection on page 81.

Chambers and bores that appear serviceable in barrels that have been fired regularly quite probably are. Critical internal dimensions, however, can't be measured by eye. All bores, chambers, and throats should be fully inspected, cast,and measured before test firing or use.



The magnum chamber shown at right was misreamed. Defects were difficult to see with barrel in receiver. Cerrosafe casting revealed the chamber defects. See page 77.

Figure 87- Shows a cutaway view of an M98 receiver and barrel chambered for a rimless type cartridge, at top. A cutaway barrel chambered for a belted magnum cartridge is shown below for comparison. Magnum bores and chambers that appeared serviceable on initial inspection are detail cleaned with powder solvent and bore/chamber brushes in preparation for further inspection and headspace checking. Belted magnum cartridges headspace on the chamber's belt recess, see arrows above, rather than on the chamber shoulder. The cartridge belt recess must be detail cleaned with powder solvent and wiped dry for headspace gauge checking. Barrels with bores and/or chambers that are unserviceable, as discussed in figure 87, must be replaced. See barrel inspection on page 81.



Headspace in bolt action rifles is defined as the distance from the closed bolt face to the back of a chambered cartridge. However, headspace is gauged from a reference point inside the chamber.

Figure 88- Shows a Forster rimless cartridge type no-go gauge installed in the chamber of a cutaway Mauser M98 barrelled action, at top. All rimless cartridges headspace from the chamber shoulder- or, specifically, from the chamber datum diameter point (a reference line on blueprints across the taper of the chamber shoulder). To simplify this subject for manufacturing and shop use, rimless headspace gauges are made with shoulder angles that are precisely the same as the matching chamber shoulder angle. When the correct headspace gauge is used in a correctly reamed chamber (with both angles equal) the gauge can't help but contact and measure headspace from the datum diameter point.

Rimless go gauges are sized to firearms industry standard dimensions for minimum chamber length. Bolts must close on go gauges. If a bolt will not close on a go gauge, the chamber is too short for standard factory ammunition.

No-go gauges made by most manufacturers typically measure about .004" to .006" longer than go gauges (depending on the specific cartridge and manufacturer of the gauge). No-go gauges are used in checking for excessive headspace. The rule is that bolts must not close on no-go gauges. If a bolt will close on a no-go gauge, headspace is excessive. This means that brass exposure is also excessive. The greater the brass exposure, the greater the potential for case head separation, case splitting, and primer problems. And, the greater the headspace, the greater the potential for bolt lug slap and receiver lug setback.

Field size gauges are maximum chamber length gauges and typically run .008" to .010" longer than go gauges. Field size headspace gauges should be used as a shop reference only.

.30-06 go and no-go gauges are shown at center. Forster belted magnum go, no-go, and field gauges are shown at bottom. Standard belted go gauges typically measure .220" thick from the front of the belt to the rim. Standard belted no-go gauges are .003" thicker than go gauges, and standard belted field gauges are .006" thicker than go gauges. The same headspace cautions and limits apply with belted magnum cartridge chambers.

Warning: if the bolt in any rifle will close on a field gauge, that rifle has dangerously excessive headspace and must not be fired under any circumstance. Do not attempt to force a bolt closed on any headspace gauge.

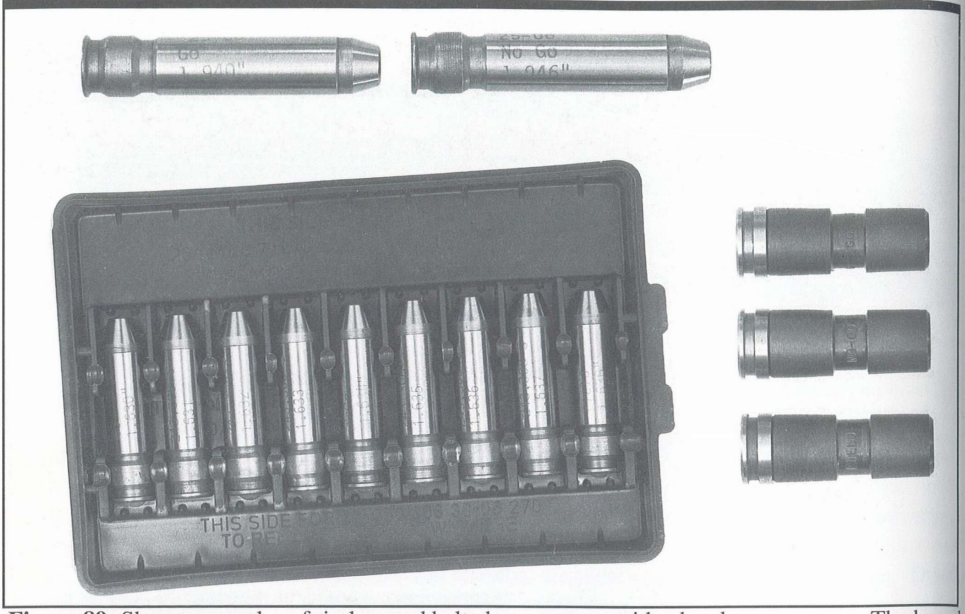


Figure 89- Shows examples of rimless and belted magnum cartridge headspace gauges. The boxed nine gauge .308 Winchester (7.62 X 51mm NATO) headspace gauge set shown, at left, includes a 1.630" standard go, a 1.634" no-go, and a 1.638" field length gauge, plus additional in between gauge sizes in .001" increments. Between size headspace gauges are normally special order, but, due to popularity, the .308 gauge set is stocked by **Brownells Inc**.

In most cases, it is possible to get by with basic go and no-go gauges in general gunsmithing work. Although consecutive gauge sets are costly, they are not as expensive as they might seem when interchangability is taken into consideration. The .308 Winchester gauge set, for example, also gauges 7.62x51mm NATO, .243 Winchester, 7mm-08, and .358 Winchester chambers.

Consecutive .001" increment headspace gauge sets are particularly useful for measuring and setting precise headspace in match rifles. Consecutive gauge sets are useful for gauging headspace when hand finish reaming chambers in newly barrelled actions and also for rechecking headspace after test firing as a means to determine receiver lug condition. In most cases, no-go gauges are too long for this purpose.

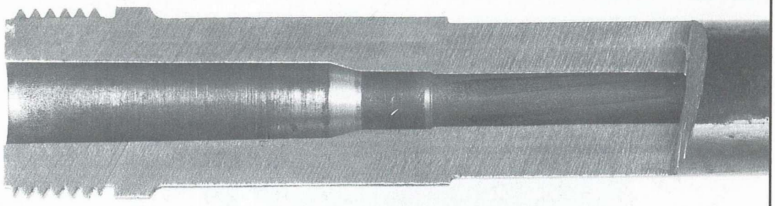
Consecutive gauge sets are also useful for tracking bolt lug and receiver lug wear and seating in heavily fired match rifles.

Headspace Gauge Interchangability, .472"-.473" Dia. Rimless Centerfire Cartridges

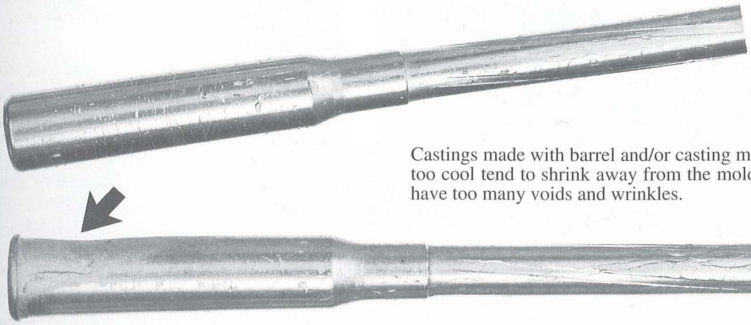
Cartridge Name	Gauge Used	Cartridge Name	Gauge Used
.22-250	.22-250	7mm-08 Rem.	.308 Win.
.220 Swift	.220 Swift	7mm Express	.280 Rem.
.243 Win.	.308 Win.	.280 Rem.	.280 Rem.
.244 Rem.	.244 Rem.	.284 Win.	.284 Win.
6mm Rem.	.244 Rem.	.300 Savage	.300 Savage
.250-3000 Sav.	.250 Savage	.308 Win.	.308 Win.
.250 Savage	.250 Savage	7.62X51mm NATO	.308Win.
.257 Roberts	7X57mm Mauser	.30-06	.30-06
.25-06	.30-06	8X57mm Mauser	8X57mm Mauser
6.5-06mm	.30-06	8mm-06	.30-06
6.5X55mm	6.5X55mm	.338-06	.30-06
.270 Win.	.30-06	.35 Whelen	.30-06
7X57mm Mauser	7X57mm Mauser	.358 Win.	.308 Win.

Headspace Gauge Interchangability, .531"-.532" Dia. Belted Magnum Cartridges

All belted magnum cartridges except the .240, .378, and .460 Weatherby use standard belted magnum go, no-go, and field gauges.



A 3" bore casting segment is usually long enough to permit cutting off the raised groove impressions on a part of the casting so that bore diameter can be measured with a standard micrometer. Cast chambers and bores with barrelled action removed from the stock and with bolt assembly and receiver parts removed. Prevent mechanical lock by limiting overpour.



Castings made with barrel and/or casting metal too cool tend to shrink away from the mold or have too many voids and wrinkles.

Figure 90- Shows a cutaway rifle barrel, at top. Castings of the chamber and about 3" of the bore made with Cerrosafe Casting Alloy are shown below. Castings are made to identify unknown chambers and to determine chamber, chamber throat, and bore dimensions.

Before casting, the chamber and bore must be well cleaned and patched dry. To stop the casting metal, push a brass rod and tight dry patch into the bore from the muzzle to within about 3" of the chamber. The barrel is then clamped in a bench vise between soft jaws with the receiver straight up.

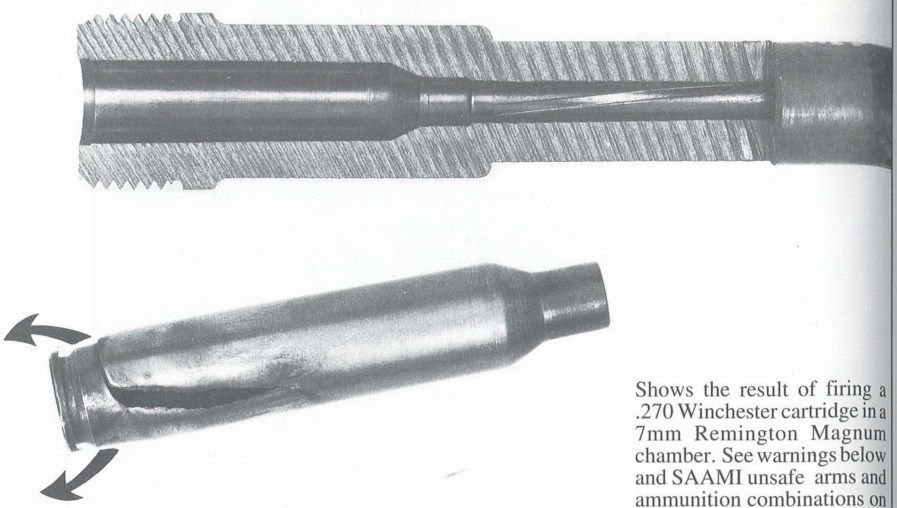
Cerrosafe melts between 158°-190°F. Melt Cerrosafe in a clean iron ladle while warming the chamber area of the barrel to approx. 100°F with an electric heat gun or hair dryer. Do not over heat. Use a funnel and tube to pour Cerrosafe into the chamber and barrel. To produce a more even casting, raise the tube as the barrel and chamber fill. Pouring Cerrosafe too cold, or into a cold barrel, creates too many bubbles and wrinkles, and can cause casting material to cool too fast and shrink away from the barrel or chamber, as shown in casting at bottom.

Cerrosafe casting alloy contracts slightly during the first thirty minutes after solidifying. The alloy expands slowly, thereafter. To prevent expansion locking, chamber and bore castings should bepushed out as soon as the casting has fully solidified- and in no case no later than thirty minutes. Sixty minutes after solidification, a Cerrosafe casting will have expanded to 100% of chamber and bore ID size. This is the ideal time to measure the casting. At the end of two hundred hours, a Cerrosafe casting will have expanded only 1/4 of 1%.

Measure the casting at the points listed below. Compare measurements against RCBS or SAAMI chamber drawings to determine if the chamber, throat, and bore dimensions are standard or whether the chamber has been improved, is a wildcat, or has been misreamed, etc. This is an important safety step. Gauging headspace may not be enough. Casting and measuring chambers and bores rules out the unknowns.

1. Measure chamber diameter at opening and case shoulder
2. Measure chamber neck diameter and length
3. Measure chamber shoulder and shoulder angle
4. Measure chamber throat and check apparent condition of throat on casting surface
5. Measure maximum bore casting diameter (same as groove diameter in bore)
6. Measure minimum bore casting diameter (same as lands diameter in bore)

Misreamed, off-center chambers; off-center or oval chamber necks and throats; chamber scoring marks; pitting, and other irregularities that are sometimes invisible when viewing the chamber through the receiver, are easily detected by inspecting and measuring chamber and bore castings.



Shows the result of firing a .270 Winchester cartridge in a 7mm Remington Magnum chamber. See warnings below and SAAMI unsafe arms and ammunition combinations on pages 82 through 85.

Figure 91- Shows a cutaway 7mm M98 military barrel, at top, that had been rechambered to 7mm Remington Magnum. This is an unsafe procedure for several basic reasons, including: (1) 7mm military barrels were made from steels intended for earlier smokeless powders and loads with much more conservative pressure curves, (2) bore and groove diameters in uncorroded military 7mm barrels are usually slightly smaller than in current 7mm sporter barrels, and (3) military barrels are too thin, particularly in the chamber area. Additionally, the above barrel was not stamped to identify the chambering. The blown .270 Winchester cartridge case, shown just below, resulted when it was fired in the 7mm Remington Magnum chamber above. High pressure powder gasses escaped from the blown, unsupported cartridge case and vented back into the receiver, as shown by arrows above.

This is one of almost countless examples of the not-so-bright placing (and sometimes forcing)wrong cartridges in chambers and creating all sorts of mishaps. When asked what happened, those who survive will often tell you that "it" (meaning the rifle) just blew up, seemingly divorcing themselves from any responsibility. These responses make me wonder if someone of this mentality would do it again, with the same righteousness. For this reason, and the fact that Mauser rifles and actions do not "just blow up", SAAMI data sheet 2.0302 and 2.0302.1, Unsafe Arms and Ammunition Combinations, 3/1/90 is included in its entirety on pages 82 through 85. In the hope that at least some of the above might be prevented, I would suggest familiarizing your customers with this data.

Although chamber identification stamping will probably not prevent the foolish from dropping cartridges into chambers to see if they will fire, it is helpful for the rest of us who exercise reasonable caution. See "Chamber Identification" on page 81.

There are a great number of causes and combinations of causes, that could rupture, separate, or blow cases, and/or damage or blow up receivers and barrels. For more information on blow-ups, I suggest reading "A Few Causes of Blow-Ups" in P.O. Ackley's Handbook for Shooters and Handloaders, Volume II.

Drilling or boring high and medium pressure centerfire rifle barrels and chambers to install barrel and/or chamber liners creates a weakened barrel/chamber condition. Thinness of the liner, voids behind the liner, and chamber/barrel liner seams, if any, add to the problem. Liner installation joints at muzzles and chambers are often difficult to see. Many Spanish manufactured military Mauser rifle barrels were made with liners. Being conservative, I find these barrels of questionable quality and I do not suggest their use under any circumstance. Replace any high or medium pressure centerfire bolt action rifle barrel that has a chamber bushing, chamber liner, or one piece chamber/barrel liner.

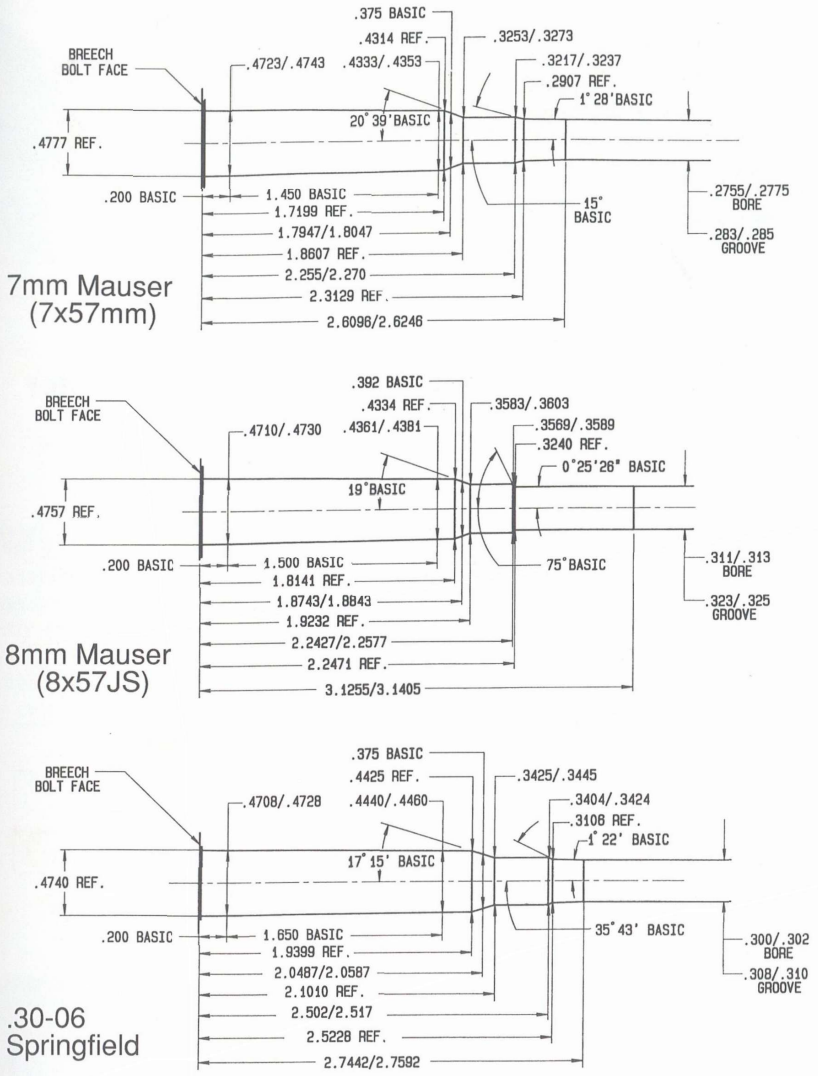
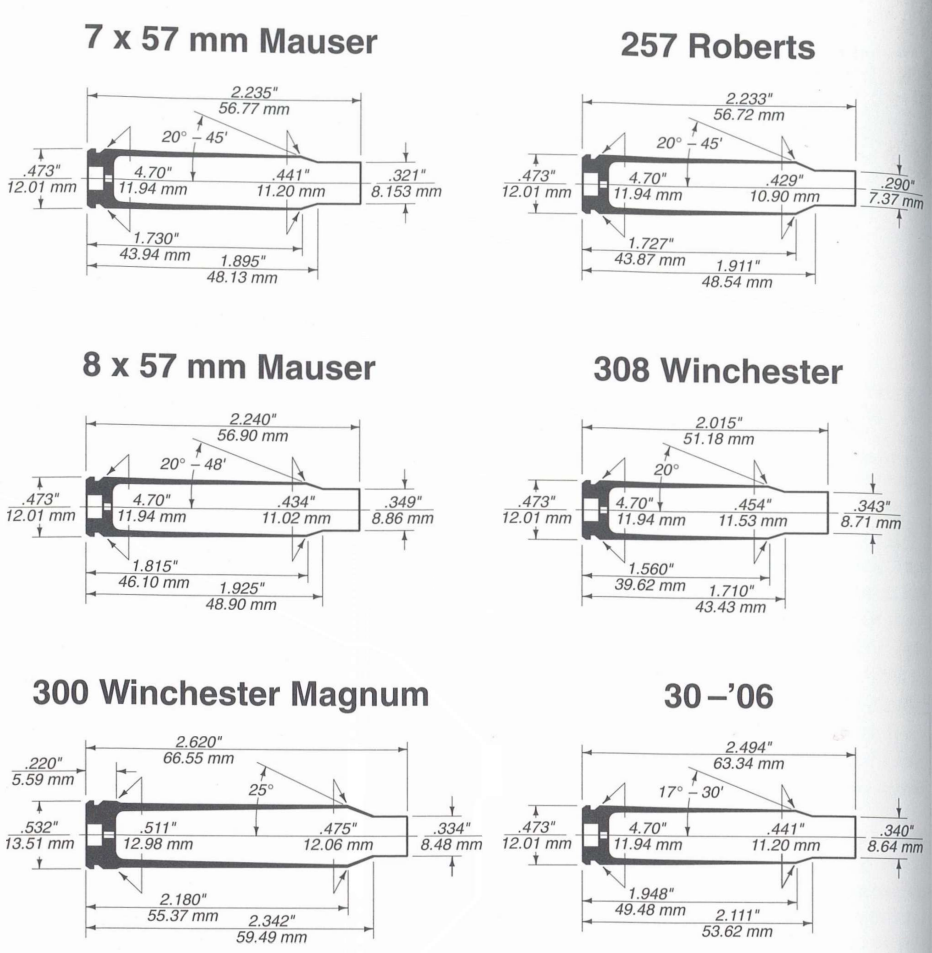


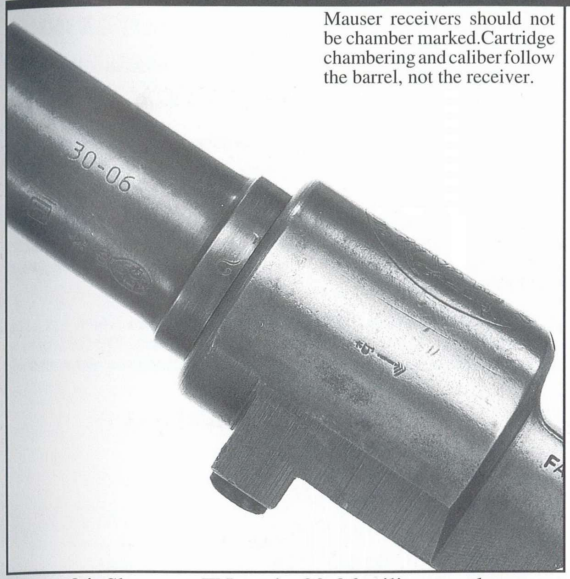
Figure 92- Illustrations show chamber dimensions for three cartridges commonly used in Mauser military and sporting rifles. Illustrations from RCBS publication, Cartridge And Chamber Drawings, by permission of RCBS Operations, Sporting Equipment Division of Blount, Inc. Although Mauser military rifles were produced primarily in 7mm and 7.9mm chamberings, Mauser military rifles, commercial sporting rifles, and basic actions have been barrelled and chambered to fire virtually every commercial centerfire rifle cartridge made.

Dimensional chamber drawings, such as the examples shown above, are a necessary shop reference for comparing and checking dimensions found on chamber, chamber throat, and bore castings. Complete sets of centerfire chamber and cartridge drawings are available from RCBS. American national standards chamber and cartridge drawings for centerfire rifles are also available in sets and individual form, from: SAAMI, 555 Danbury Road, Wilton CT, 06897. The SAAMI set is ordered as: ANSI/SAAMI Z299.4-1986, centerfire rifle.



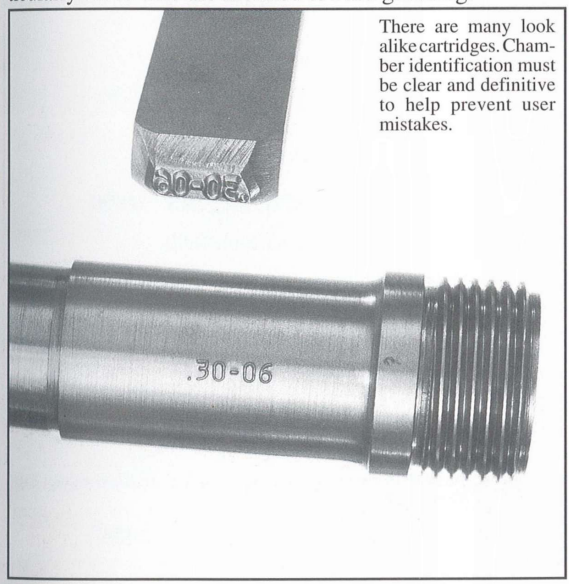
Sized cartridge case drawings are shown here for reference and comparison with RCBS chamber drawings on page 79. These drawings are not provided for and should not be used for reloading purposes. Consult Speer Reloading Manuals for case reloading dimensions, case preparation, and other reloading data.

Figure 93- Illustrations show several common cartridge cases and standard sized cartridge case dimensions. The above drawings were redrawn from illustrations in Speer Reloading Manual #11 by VSP staff artists. Use of the original cartridge case drawings by permission of Speer Operations, Sporting Equipment Division of Blount, Inc. The cartridge case and neck diameters, and overall lengths, shown above, are slightly smaller than actual finished chamber diameter and length to provide loading and expansion clearance. Without industry chamber drawings at hand, there is the tendency for some gunsmiths to use new factory ammunition or resized cartridge cases as a gauge or reference when dimension checking chambers or chamber castings. This procedure is not recommended for two reasons: 1. cartridge case sizing die and chamber finishing reamer tolerances vary to some extent and produce plus and minus variations in both cartridge case and chamber final sizes; and, 2. measurement of an "average" cartridge or cartridge case will not provide chamber maximum-minimum diameter and length data found only in industry chamber drawings.



Mauser receivers should not be chamber marked. Cartridge chambering and caliber follow the barrel, not the receiver.

Figure 94- Shows an FN made .30-06 military replacement barrel installed on an M98 action. This factory unmarked barrel was stamped on the left side by the installing gunsmith to identify the cartridge the barrel was chambered for. Chambering marks should be slightly above stock line and fully visible. Chamber identification is helpful to all, particularly those who are inclined toward guessing.



There are many look alike cartridges. Chamber identification must be clear and definitive to help prevent user mistakes.

Figure 95- Shows a chamber identification imprint on a replacement military barrel. A chamber identification stamp is shown, above. Imprints must be straight and deep enough to remain fully visible after flaring is removed and the barrel is polished. Stamp handguard covered barrels at 12:00 o'clock to make the chamber mark obvious when the hand guard is removed. Stamps available from **Brownells, Inc.**

Chamber Identification

Replacement barrels and custom sporter barrels must be clearly stamped to identify cartridge chambering. See figures 94 & 95. Chamber identification isn't just a courtesy; it also serves as a positive safety reminder to any person who might load and fire the rifle.

Chambering marks such as .257 Roberts, 7X57mm, .30-06, and .300 Winchester Magnum, are good examples because both the caliber and the cartridge are given.

Original wildcat designations such as 7mm-08 and .22-250 are also easily recognized. Common wildcat designations such as the 6mm-250 and .35 Whelen, are also clear. Other wildcats, including the improved cartridges, must be clearly designated to prevent mistakes. A "7X57mm Ackley Imp." imprint, for example, would exactly indentify the particular version of the 7X57 improved cartridge that the barrel had been chambered for.

A .243 RCBS imprint would indicate that the barrel definitely was not chambered for the standard .243 Winchester cartridge.

Chambering Imprint Stamps Don't Tell All

Crafty shooters have been known to fireform cartridge case shoulders forward to make rimless cartridges headspace in rifle chambers with excessive headspace. They do this on their own responsibility; treating these chambers as if reamed to an improved dimension, and resize case necks, only, thereafter. This procedure may not be as safe as fireforming improved cartridge cases, depending on the extent to which headspace is excessive; size and condition of the chamber; and hardness and condition of the brass.

The main trouble with rifles in this condition is that an unaware shooter may believe the chamber imprint stamp and load and fire standard ammunition in the rifle.

SAAMI Data Sheet 2.0302 & 2.0302.1 UNSAFE ARMS AND AMMUNITION COMBINATIONS 3/1/90

Ammunition used in a firearm must be the same caliber or gauge as that marked on the firearm by its manufacturer. If the firearm is not marked as to caliber or gauge, or if it appears that the original marking has been overprinted or changed, it is the responsibility of the gun user to have a qualified person determine what cartridge or shell can safely be used in the firearm.

The firing of a cartridge or shell other than that for which the firearm is chambered can result in the cartridge or shell rupturing and releasing high pressure gas that can damage or destroy the firearm and kill or seriously injure the shooter and persons nearby.

There are countless combinations of specific cartridges and firearm chambers which are unsafe. Many of these unsafe combinations are recognizable because of significant dimension differences between the similar chamber and cartridge dimensions. It is not possible to list every unsafe combination; therefore, in the interest of safety, use only the cartridge (or shell) designated by the firearm or ammunition manufacturer for use in a specific firearm. The cartridge caliber or shotshell gauge must be marked on the firearm frame, receiver or barrel by its manufacturer.

The practice of rechambering firearms is not guided by industry standards. It is possible that a firearm which has been rechambered may not be rechambered properly or the rechambered caliber may not be marked on the firearm. The firearm user is responsible to find out from a qualified person the cartridge caliber or shell gauge for which the firearm has been rechambered.

RIMFIRE:	In Firearms Chambered For	Do Not Use These Cartridges
	22 WRF	22 BB, 22 CB 22 Short 22 Long 22 LR 22 LR Shot
	22 WMRF	22 BB, 22 CB 22 Short 22 Long 22 LR 22 LR Shot
	22 Win Auto	22 BB, 22 CB 22 Short 22 Long 22 LR 22 LR Shot
	5mm Rem RF Magnum	22 BB, 22 CB 22 Short 22 Long 22 LR 22 LR Shot 22 Win Auto
	25 Stevens Long	5mm Rem RF Magnum

SAAMI Data Sheet 2.0302.1 UNSAFE ARMS AND AMMUNITION COMBINATIONS 3/1/90

SHOTGUN:	In Shotgun Chambered For	Do Not Use These Shells
	10 Gauge	12 Gauge
	12 Gauge	16 Gauge
	12 Gauge	20 Gauge
	16 Gauge	20 Gauge
	20 Gauge	28 Gauge

In Shotgun Chambered For	Do Not Use These Centerfire Metallic Cartridges
410 Bore	Any

With any gauge, shotshells of a given nominal length should not be fired in a gun the chamber length of which is shorter than the fired shell length, e.g. a 3" (75mm) shell fired in a 2 3/4" (70mm) chamber.

SAAMI Data Sheet 2.0302.1 UNSAFE ARMS AND AMMUNITION COMBINATIONS 3/1/90

CENTERFIRE PISTOL & REVOLVER:

In Firearms Chambered For	Do Not Use These Cartridges
9mm Luger (Parabellum)	9mm NATO (Military)
32 H&R Mag	32 Long Colt
32 S&W	32 Auto 32 Long Colt 32 Short Colt

SAAMI Data Sheet 3.0303 UNSAFE ARMS AND AMMUNITION COMBINATIONS 3/1/90

CENTERFIRE PISTOL & REVOLVER (Continued)

In Firearms Chambered For	Do Not Use These Cartridges
32-20 Win	32-20 High Velocity
38 Auto	38 Super Auto +P * 9mm Luger
38 Super	9mm Luger
38 S&W	38 Auto 38 Long Colt 38 Short Colt 38 Special
38 Special	357 Magnum 380 Auto
38-40 Win	38-40 High Velocity
44-40 Win	44-40 High Velocity
45 Auto	38-40 Win 44 Rem Magnum 44 Special 44-40 Win
45 Colt	38-40 Win 44 Rem Magnum 44 S&W Special 44-40 Win 454 Casull

* +P Ammunition is loaded to a higher pressure, as indicated by the +P marking on the cartridge case headstamp, for use only in firearms especially designed for this cartridge and so recommended by the manufacturer.

SAAMI Data Sheet 2.0303 & 2.0304 UNSAFE ARMS AND AMMUNITION COMBINATIONS 3/1/90

CENTERFIRE RIFLE:

In Firearms Chambered For	Do Not Use These Cartridges
6mm Remington (244 Rem)	250 Savage
6.5mm Remington Magnum	300 Savage
7mm Express Remington	7mm Mauser (7x57) 270 Winchester 30 Remington 30-30 Winchester 300 Savage 308 Winchester 32 Remington 375 Winchester 38-55 Winchester
7mm Mauser (7x57)	300 Savage 30-30 Win
7mm Remington Magnum	7mm Express Remington 7mm Mauser (7x57) 7mm Weatherby Magnum 8mm Mauser 270 Winchester 280 Remington 303 British 308 Winchester 35 Remington 350 Remington Magnum 375 Winchester 38-55 Winchester
8mm Mauser (8x57)	7mm Mauser (7x57) 35 Remington
8mm Remington Magnum	338 Winchester Magnum 350 Remington Magnum 358 Norma Magnum 375 Winchester 38-55 Winchester
17 Remington	221 Remington Fireball 30 Carbine

SAAMI Data Sheet 2.0304 & 2.0304.1 UNSAFE ARMS AND AMMUNITION COMBINATIONS 3/1/90

CENTERFIRE RIFLE: (Continued)

In Firearms Chambered For	Do Not Use These Cartridges
17-223	17 Remington 221 Remington Fireball 30 Carbine
223 Remington	5.56 Military 222 Remington 30 Carbine
243 Winchester	225 Winchester 250 Savage 300 Savage
257 Roberts	250 Savage
264 Winchester Magnum	270 Winchester 284 Winchester 303 British 308 Winchester 350 Winchester 375 Winchester 38-55 Winchester
270 Winchester	7mm Mauser (7x57) 30 Remington 30-30 Winchester 300 Savage 308 Winchester 32 Remington 375 Winchester 38-55 Winchester
280 Remington	7mm Mauser (7x57) 270 Winchester 30 Remington 30-30 Winchester 300 Savage 308 Winchester 32 Remington 375 Winchester 38-55 Winchester
284 Winchester	7mm Mauser (7x57) 300 Savage
30-06 Springfield	8mm Mauser (8x57) 32 Remington 35 Remington 375 Winchester 38-55 Winchester
30-40 Krag (30 govt)	303 British 303 Savage 32 Winchester Special

SAAMI Data Sheet 2.0304.2 UNSAFE ARMS AND AMMUNITION COMBINATIONS 3/1/90

CENTERFIRE RIFLE:

In Firearms Chambered For	Do Not Use These Cartridges
300 Holland & Holland Magnum	8mm Mauser (8x57) 30-06 Springfield 30-40 Krag 375 Winchester 38-55 Winchester
300 Weatherby Magnum	338 Winchester Magnum
300 Winchester Magnum	8mm Mauser Rd. Nose Bullet 303 British 350 Remington Magnum 375 Winchester 38-55 Winchester
303 British	30-30 Winchester 32 Winchester Special
303 Savage	30-30 Winchester 32 Winchester Special 32-40 Winchester

SAAMI Data Sheet 2.0304.2 UNSAFE ARMS AND AMMUNITION COMBINATIONS 3/1/90

CENTERFIRE RIFLE: (Continued)

In Firearms Chambered For	Do Not Use These Cartridges
308 Winchester	300 Savage
338 Winchester Magnum	375 Winchester 38-55 Winchester
348 Winchester	35 Remington
375 Winchester	38-55 Winchester 41 Long Colt
375 H&H Magnum	375 Winchester 38-55 Winchester
38-55 Winchester	375 Winchester 41 Long Colt
416 Rigby	416 Remington
416 Weatherby	416 Remington 416 Rigby

SAAMI Unsafe arms and ammumition combinations list, reprinted in its entirety, courtesy of Sporting Arms and Ammunition Manufacturers Institute, Inc.

Supplemental safety warning: Cartridge chambering was not stamped on military rifles by Mauser or Mauser's affiliates, because the government for which the rifles were produced knew exactly what cartridge the rifles were chambered for.

By now, many military bolt action rifles have been rebarrelled to other calibers. Many sporter conversions have been built on Mauser military actions using military or custom sporter barrels. Many rifles in both categories are found without chamber identification imprints. Barrels are found that have been rechambered for other than the original cartridge or that have had original chambers recut and deepened during barrel requalification.

Chambers and bores in military rifles and sporter conversions also can be found in every possible level of condition; from fully serviceable to downright dangerous. For this reason, all chambers and bores must be closely inspected, Cerrosafe cast, and the castings measured. See Cerrosafe bore/chamber casting in figure 90.

A slightly different subject having to do with chambers and cartridges is the strength limitation of the small ring M91~M96 Mauser actions and the Spanish made small ring M93 and M95 Mauser actions in particular. Mauser M91~M96 actions, even in fully serviceable or in as-new condition, must not be barrelled and chambered for, or fired with, higher pressure cartridges than the action was originally made for. An example of stretching this rule is found in the arsenal rebarrelling and chambering of M93/M95 small ring Spanish Mauser actions to fire the 7.62mm CETME cartridge. The M93/M95 actions used were originally made for lower pressure 7x57mm Mauser cartridges. After conversion, these rifles and carbines were redesignated as 1916 Models. At normal temperatures, the 7.62mm CETME cartridge generates pressures in roughly the 41,500 to 42,000 CUP range in a correctly dimensioned chamber and bore.

To compound the above, a 7.62x51mm NATO (or .308 Winchester) cartridge will chamber in a 1916 Model 7.62mm CETME chamber. However, a 7.62mm NATO or .308 Winchester cartridge can generate pressures of about 55,200 CUP. **This pressure range is dangerous even in a well heat treated German or Swedish made small ring M91~M96 Mauser action but, in my opinion, can be particularly dangerous in the much softer Spanish made actions**. A lot of Spanish made M93 and M95 Mausers are still around that are chambered for the 7x57mm cartridge. Due to the known softness of the Spanish made Mauser actions and limited receiver/barrel thread bearing area, etc., most manufacturers of 7x57mm Mauser ammunition restrict operating pressures as close to 37,000 CUP as possible as a safety factor.

A Caution About Military M98 Magnum Conversions-

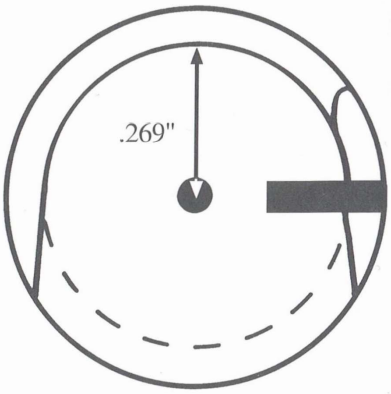
I strongly suggest limiting cartridge conversions in standard length M98 military and commercial receivers to cartridges that do not exceed the maximum overall length of the .30-06 cartridge. In magnum cartridges, this would include: .7mm Remington, .300 Win., .338 Win., and .458 Win. magnums. The .308 and .358 Norma magnum and the 7X61mm S&H would be additional choices.

Converting standard length M98 actions to fire longer cartridges such as the .300 H&H Magnum (3.655" max. OAL) requires extensive modification of the receiver feeding ramp behind the bottom receiver lug. Removal of enough steel in this area to permit the action to ramp cartridges of this length weakens the receiver at the bottom lug engagement area. See figure 97. Magnum operating pressures can exceed 57,000 CUP. These cartridges require a stronger, not a weaker, receiver.

Some standard length late commercial M98 receivers made from alloy steels have factory magazine openings large enough to accommodate .300 and .375 H&H cartridges. Even though these alloy steel receivers are generally harder in the lug engagement areas, and less inclined to permit lug setback, as far as I'm concerned, reduced metal thickness at the bottom receiver lug does not inspire confidence.

In any case, I suggest staying well below industry standard maximum operating pressures with these actions. Work up loads carefully and check headspace between test firings. A slightly longer throat can help to control pressure curves.

M98 bolt face openings, see figure 96, can be enlarged to receive larger diameter belted cartridge rims. Bolt faces must be kept at 90° to bolt body centerline. Bolt faces should not be cut more than .010" below the original factory face when opening the bolt face or when refacing is required. See pages 169~171.



Note: Opening and truing bolt faces usually cuts through the remaining case hardening on the bolt face. Bolts should be reheat treated after bolt face work.

Figure 96- Illustration shows belted magnum cartridge recess and basic bolt face detail found in late M98 commercial sporter bolts. Although recess diameter varies somewhat in factory and converted bolts, ideal recess opening size is .532" (standard belted magnum rim diameter) plus about .005"-.006" for loading clearance. Bolt face opening radius from the center of the firing pin port would be approx. .269".

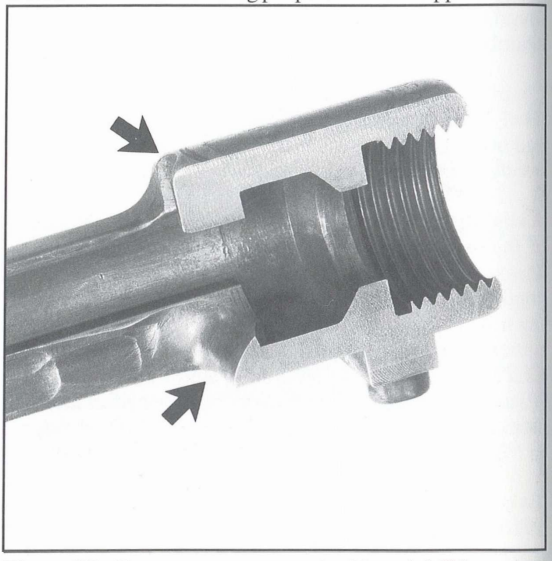


Figure 97- Shows a cutaway standard length M98 receiver that has been notched at the back of the ring and ramped forward to enable the action to feed .300 H&H cartridges, see arrows above. Removing metal from behind the lugs weakens carbon steel M98 receivers. High pressure magnum cartridges require maximum receiver strength, not less.

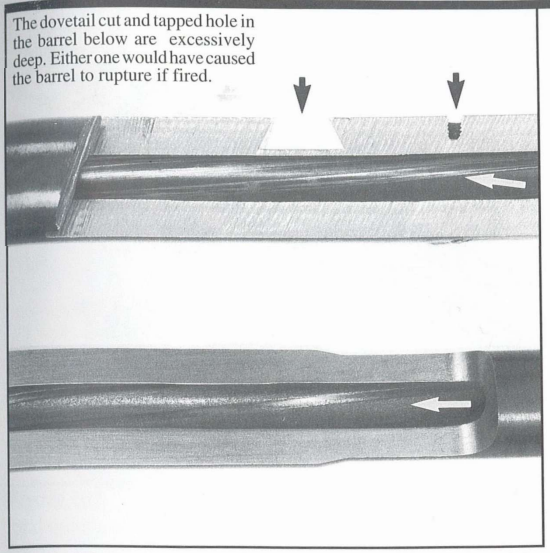


Figure 98- Shows cutaway Mauser barrel sections. The bore in the ruined barrel, at top, has been gouged with a steel rod. The bore, below, was pitted by corrosive priming residue that was not fully removed; a condition commonly found in military rifle bores. Routine cleaning and brushing has controlled rust activity except at the bottom of the pits.

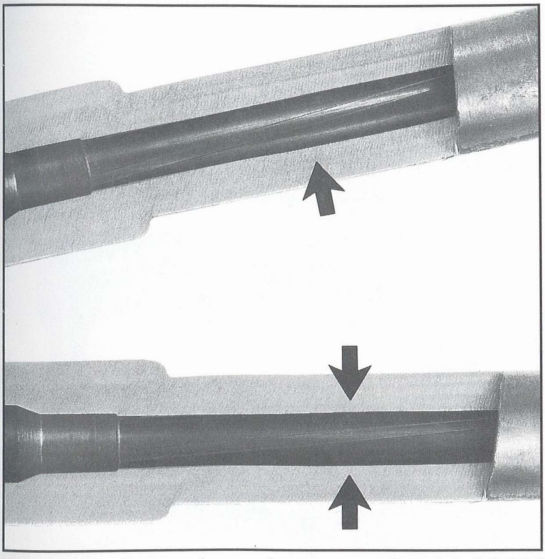


Figure 99- Shows views of a cutaway Spanish M1916 barrel with an area that is expanded about .010", see arrows above. This bulge was easily detected after the barrel had been cleaned, and was probably caused by firing through a restriction in the bore such as grease. Bore irregularities are sometimes found in lined M93/M95 Spanish barrels.

Final Barrel Inspection

If it hasn't been done previously, M91~M98 barrel interiors must be detail cleaned and fully inspected before continuing with parts checks and final assembly of the receiver parts group. See figures 98 and 99. Also see figures 86 through 90. If the barrel and bore are serviceable, and the chamber headspaces correctly, continue checkout and assembly of the receiver parts group.

Further Barrel Cautions

Barrels that are bent or tweaked; barrels that are nonconcentric; barrels that have slightly oversize bores (worn out from heavy use or by brushing out corrosive primer pitting); barrels with bores that have been gouged or scratched, and/or that have oversize chambers or chamber throats that are eroded or cut too long, are usually inaccurate and should be replaced.

Barrels that are rusty; that have large rust pits; that are bulged or cracked; that are not straight; that have holes drilled into the thread area or holes drilled past the depth of five 6-48 threads; that have undersized and/or out of round bores; that have been turned to a too thin profile or that have other damage and/or defects, are dangerous, or potentially dangerous, and must be replaced. Unserviceable barrels are removed and replaced as shown in Sect. II. See "Safety and Common Sense" on pages 112~116. Also see page 153.

Early 8mm Barrel Warning

8mm (7.9X57) M98's made before 1905 were chambered for the old M1888 service cartridge. Lands and groove diameters were .311" and .320". Although most of these old barrels were replaced long ago, a few may still exist. Firing a later, larger, .323" diameter "S" type bullet in these old barrels creates dangerous pressures. See chamber/barrel casting on page 77.

Inspect Muzzle Crown

Military rifle barrels are commonly found with muzzle crowns that have been worn into an irregular shape or that have been scrubbed to one side and out of round. This condition is caused by cleaning barrels in the field from the muzzle end. Crown nicks or dents that extend into the bore can tear or cut a gas escape vent into the side of a bullet. A worn, uneven, or nicked crown will also permit gas venting. In any case, unless the lands and grooves end smoothly, evenly, and at exactly 90° to bore centerline, propellant gasses will vent unevenly around the base of the bullet just as it clears the muzzle. To greater or lesser degree, this deflects bullets and generally destroys accuracy in otherwise serviceable barrels.

About Barrel Concentricity & Precision Muzzle Crowning-

Manufacturing tolerances in mass produced military rifle barrels permit a fair amount of plus/minus variation in both barrel dimensions and concentricity.

Although barrel O.D. comes closer to being concentric with the bore at the ends of military barrels, concentricity isn't a given. Perfect concentricity wasn't necessary for installation of sleeve type sight bases. When the muzzle end of a non-concentric barrel is chucked, the bore will rotate off center. For this reason, the barrel exterior at the muzzle must be concentricity checked and trued before precision lathe crowning, as discussed in Section II.

As an alternative, barrel faces and muzzle crowns can be recut with piloted hand cutters, except when lathe muzzle shortening is required. Piloted hand operated crowning cutters and hand laps are shown in figure 101.

When the bolt assembly, receiver, and barrel have been determined to be in serviceable condition, trigger/sear assembly parts can then be inspected and installed.

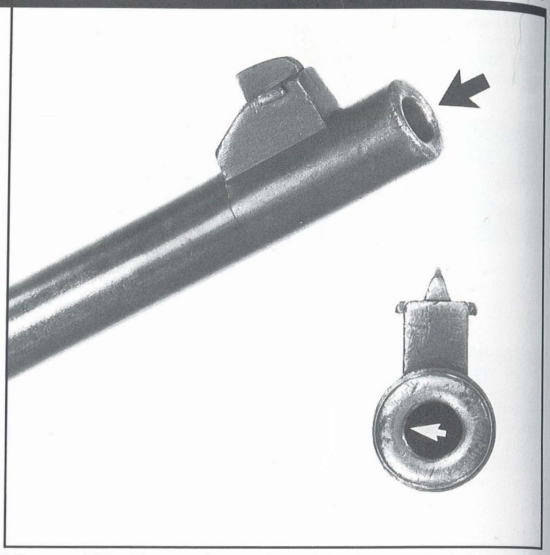


Figure 100- Shows views of scrubbed out and nicked M98 muzzle crowns. Scrubout wear is caused by abrasive grit and cleaning rod friction against the edges of the crown. Muzzle crowns in this condition allow gas blow-by to deflect bullets just as they clear the muzzle, making range performance erratic or inaccurate in otherwise serviceable barrels.



Figure 101- Shows piloted, hand operated muzzle facing and crown chamfering cutters, above. Brass muzzle crown hand laps, shown below,were designed by Ron Power. Crowning tools are available from Brownells, Inc. Lathe recrowning, shown in Section II, requires that the outside of the barrel must be concentric with the bore at the muzzle.

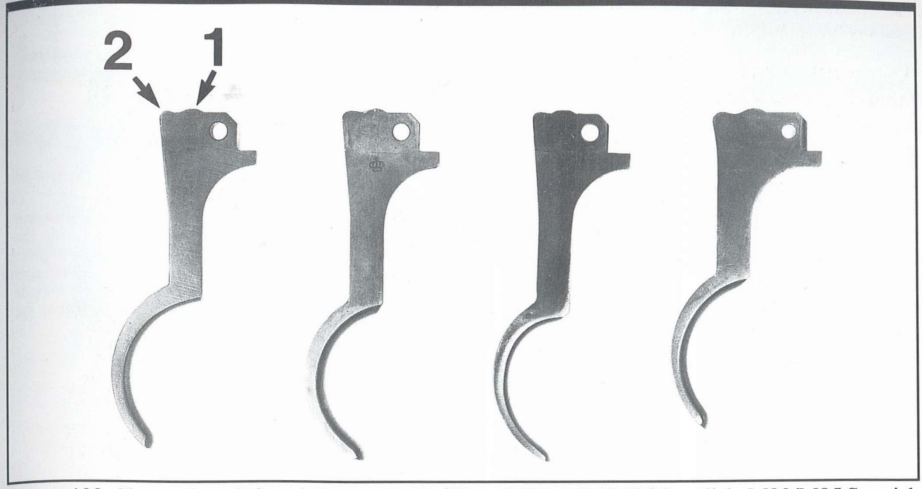


Figure 102- Shows, from left to right: standard military M98, M94/M96 Swedish, M92/M95 Spanish (and other), and M91 Argentine/Spanish type Mauser trigger levers for comparison. These triggers are all two-stage. The first stage cam, at **1,** lowers the sear about half way as about half of the slack in the trigger is taken up. The second stage cam, at **2**, then continues to draw the sear down until the sear releases the cocking piece sear engagement ledge. If the second stage cam is excessively worn or has been altered, the first stage cam will be required to overtravel in order to draw the sear down far enough to release the firing mechanism. Although there are other causes, this, by itself, can cause sear drag and trigger creep. If the first stage cam is undersize, the sear will ride too high in the receiver and slightly overengage the cocking piece. This condition is not unsafe, but is another cause of sear drag. A first stage cam that is too tall can cause the sear to underengage the cocking piece.

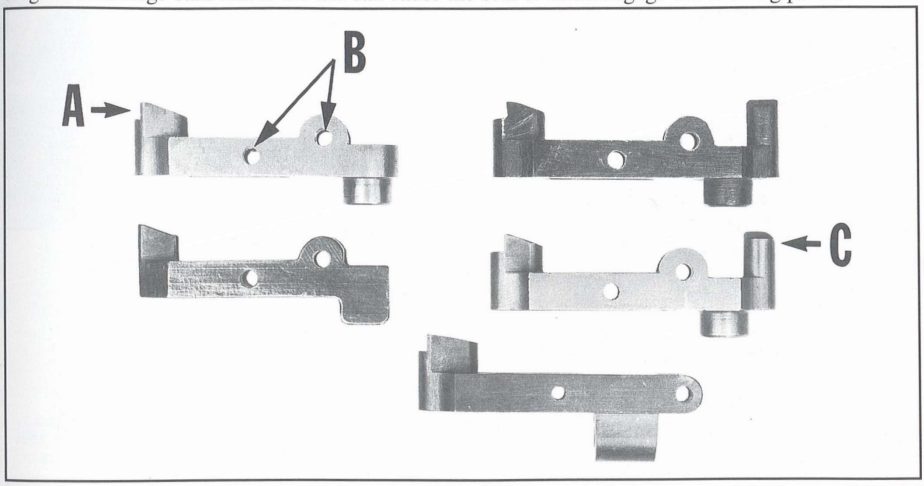


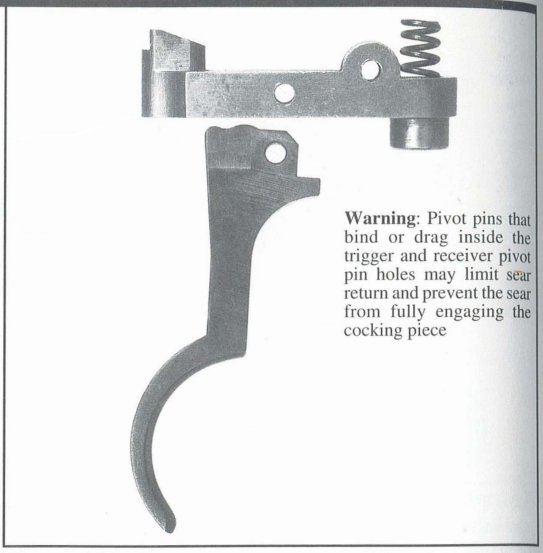
Figure 103- Shows two M98 military sear body variations, at left. M92~M95 (and other), M94/M96 Swedish, and M91 Argentine/Spanish type sear bodies are shown from top to bottom, at right, for comparison. M92 ~M96 sear bodies are easily identified by the presence of the safety interlock stud at the front. While similar, these sear bodies do not interchange because of slight dimensional differences. The sear's cocking piece engagement surface, at **A**, must not be altered or damaged. If the surface is galled or wavy, the sear is soft and must be replaced. The sear and trigger pivot holes, at **B**, must not be oversize. The safety interlock stud, at **C**, must be tall enough to block trigger/sear function, but not so tall that the stud drags the bolt body. If in doubt about the condition of a trigger lever or sear body, compare against correct model parts in serviceable condition.

Inspect and Install M92~M98 Military Trigger Parts Group

Make sure that trigger/sear assembly parts are correct for the Mauser action model being assembled. If there is any question, compare parts against correct model replacements in serviceable condition.

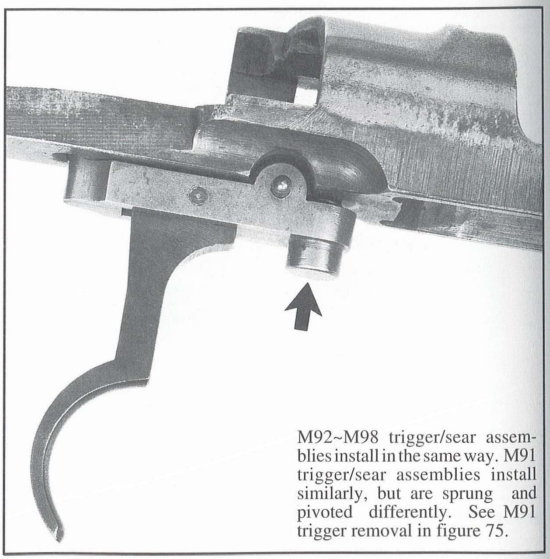
M92~M98 trigger/sear assembly parts are similar, see figures 102 and 103, but do not interchange between model groups.

1. Detail clean and inspect the sear body. Remove dried oil and dirt from the interior with a brass brush and solvent. The cocking piece engagement surface must not be altered, pitted, or damaged. Pivot pin holes must not be oversize.
2. Inspect trigger lever and first and second stage cam surfaces. See figure 102. Replace if altered or damaged.
3. Inspect the sear spring. Although sear spring sizes vary somewhat, diameter and length should not be smaller than .250" x .700" long. The sear spring must be strong enough to produce at least 3 1/2 lbs. of trigger pull by itself in a serviceable action with a military type trigger. See slam and impact fire warnings, page 98.
4. Inspect trigger/sear pivot pins. Pins should fit pin holes in the sear body with light drag but must not cause the trigger or sear to drag or bind. Replace pivot pins that are pitted, bent, undersize, and/or deformed from peening. See warning in figure 104.
5. Install trigger and pivot pin in sear body and check for free movement. If the trigger drags or sticks, polish the sides with #400 sandcloth and/or replace the pivot pin.
6. Place the sear spring in the sear body and install the trigger/sear assembly as shown in fig 105.
7. Check for smooth trigger/sear travel and full return.
8. Check for correct sear rest position. See page 91.



Warning: Pivot pins that bind or drag inside the trigger and receiver pivot pin holes may limit sear return and prevent the sear from fully engaging the cocking piece

Figure 104- Shows Mauser M98 military trigger/sear assembly parts. The sear spring is critical and must be full length and full strength. A weak sear spring can permit sear bounce, slam fires, and/or impact fires. Trigger and sear pivot pins must fit snugly in the pivot holes in the sear body, but must not drag or bind in trigger or receiver pin holes.



M92~M98 trigger/sear assemblies install in the same way. M91 trigger/sear assemblies install similarly, but are sprung and pivoted differently. See M91 trigger removal in figure 75.

Figure 105- Shows installing a military trigger/sear assembly on an M98 receiver. The sear spring is compressed with thumb pressure. The sear body and receiver pivot pin holes are then lined up with fingers and held in position while the sear pivot pin is hand started. Slightly loose pivot pins can be lightly peened on ends to prevent back-out.

Altering the second stage cam in an attempt to tune a military trigger or convert it to crisp single stage function does not work. Quite the reverse happens: trigger mushiness and sear/trigger drag increase. Modified triggers must be replaced.

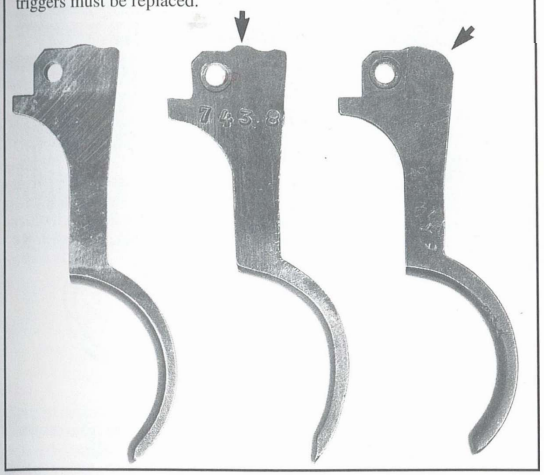


Figure 106- Shows close views of M98 military triggers. Cams on the trigger at left are in serviceable condition. The first stage cam on the center trigger is too high. This could, in turn, hold sear rest position low and lessen vertical cocking piece engagement. The 2nd stage cam on the trigger at right has been altered in an attempt to create a single stage trigger. Altered triggers must be replaced.

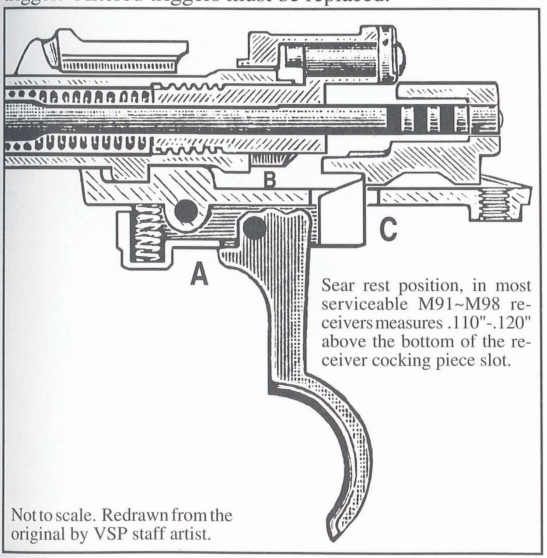


Figure 107- Half sectional illustration shows an M98 military trigger/sear assembly after installation. The trigger is in correct position with the trigger stop, at **A**, riding on the sear body. The trigger's first stage cam, at **B**, is against the receiver bottom. Sear rest position, at **C**, is within the average range of .110"-.120" above the receiver's cocking piece slot.

About Mauser Two Stage Military Trigger Function-

The two stage sear/trigger mechanism used in M91~M98 Mauser military rifles was designed for durability, easy maintenance, and ease of mass production. It has a built-in forgiveness for dirt and slightly off tolerance replacement parts. Although these triggers are not crisp compared to most single stage triggers, they are much simpler and come very close to being foolproof in the field.

Sear rest position and sear related vertical cocking piece engagement is primarily controlled by the height of the trigger first stage cam. See figures 106 and 107.

As the trigger is squeezed, the first stage cam draws the sear about one-third to halfway down from rest position. The second stage cam then takes over and continues drawing down the sear until the cocking piece and firing mechanism is released.

Regardless of age, there are few problems with these simple trigger mechanisms. Problems that are found are largely caused by corrosion, dirt impaction, sear/trigger alteration, weak or wrong springs, and undersized or wrong pivot pins.

Check Sear Rest Position

In Mauser two stage military triggers, vertical sear rest position (how far the sear extends upward from the bottom of the receiver cocking piece slot) is determined by existing parts tolerances and the height of the first stage trigger cam in particular.

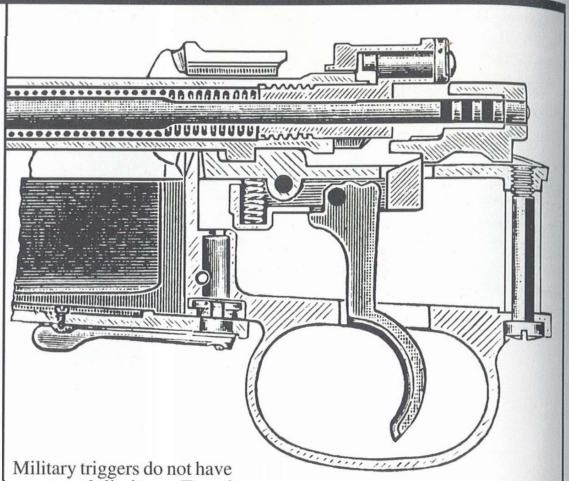
I have not seen a max./min. specification for sear rest position for the M91~M98 models. Sear heights in the actions I have checked have varied from .090" to .135". More than 80%, however, measured in the .110"-.120" range. In otherwise serviceable actions, this measurement can be used as a working specification because it permits sufficient sear/cocking piece ledge engagement when the cocking piece used has correct ledge dimensions.

Sear Rest Position, Continued-
When sear rest position is much higher, increased sear/cocking piece engagement can make the trigger drag or feel stiff, depending on firing pin spring tension.
If sear rest position is lower than .110"-.120", sear/cocking piece engagement may not be sufficient.

Adjust Low Sear Rest Position
1. Inspect sear and trigger pivot pins first. Replace undersized, altered, or damaged pivot pins.
2. If low rest position is caused by an altered sear body or an oversized sear pivot pin hole in the sear body, replace the sear body and recheck.
3. If the receiver, sear body, and pivot pins are serviceable and sear rest position is low by more than .010", select a replacement trigger with a lower first stage cam.
4. If rest position is still slightly low after trigger replacement, and receiver and trigger/sear assembly parts are serviceable, reduce trigger first stage cam height with a fine stone to raise sear rest position.

Military Trigger Overtravel
Mauser military triggers are not made with travel stops. Rearward travel ends when the trigger stops against the sear body or the back of the trigger window in the trigger guard. Clearance the trigger guard window, as needed, to permit full trigger travel and return.

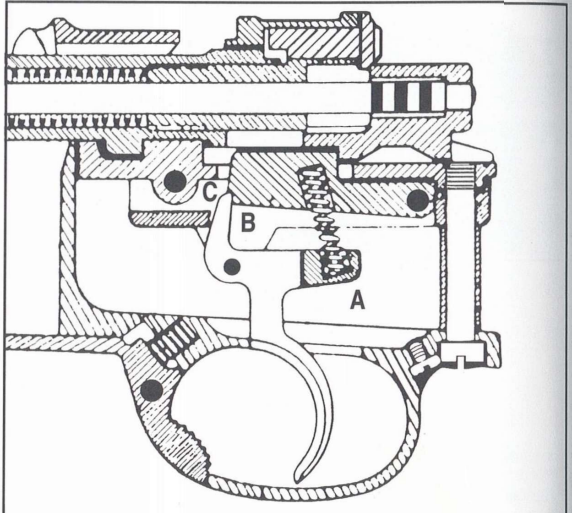
Custom and Sporter Triggers
Custom accessory and various factory sporter single stage triggers divide into two basic categories:
1. Trigger assemblies without safety mechanisms, designed and intended for use with the original military bolt sleeve and firing pin safety system in place.
2. Triggers with built-in safety mechanisms and separate, usually side mounted, safety levers.
Streamlined commercial M98 bolt sleeves can be used only with trigger assemblies with built-in sear or trigger block safety mechanisms. Military bolt sleeves with firing pin safety levers must be used with any trigger mechanism that does not have an integral safety.



Military triggers do not have overtravel limiters. Travel stops when the back of the trigger lever contacts either the sear body or trigger guard.

Not to scale. Redrawn from original illustration by VSP staff artist.

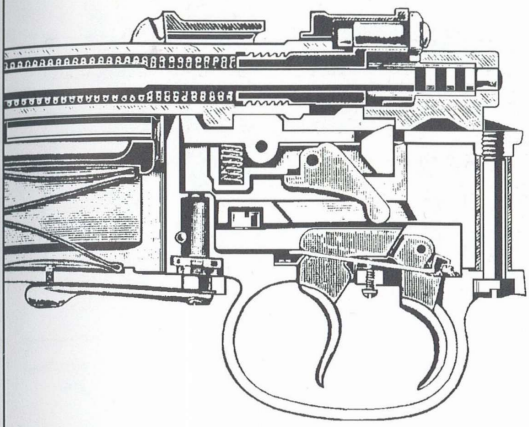
Figure 108- Shows trigger guard temporarily installed to check for free trigger travel and return. Drag or bind inside the trigger guard's trigger window is most often caused by a bent trigger lever or an undersized window. A mismatched trigger guard (small bow) and long trigger may either not fit at all or cause contact or bind at the bottom of the trigger.



Not to scale. Redrawn from original illustration by VSP staff artist.

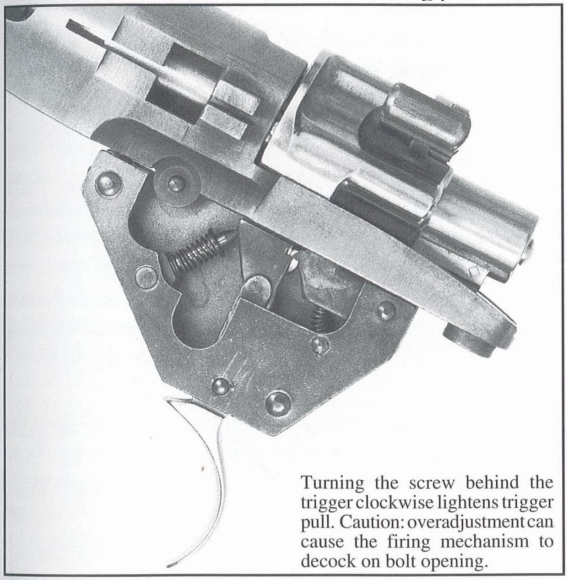
Figure 109- Shows a single stage trigger mechanism used in some Oberndorf Mauser sporters. The trigger/sear spring, at **A**, trigger sear point, at **B**, and sear notch, at **C**, must hold primary sear/cocking piece engagement. A weak trigger/sear spring or worn sear engagement can permit slam and/or impact fires. A minimum trigger pull of 4 lbs. is suggested with this trigger design.

Not to scale. Redrawn from original illustration by VSP staff artist.



Several accessory double set triggers have been manufactured that are variations on this traditional double trigger design.

Figure 110- Illustration shows a double set trigger used in an early Oberndorf M98 sporter. The front trigger is the set trigger. The screw shown adjusts set trigger sear engagement and final pull. The rear trigger compresses the kicker spring, cocks the kicker, and engages the set trigger sear. When squeezed, the set trigger releases the kicker which impacts the kick-off lever and cams down the cocking piece sear.



Turning the screw behind the trigger clockwise lightens trigger pull. Caution: overadjustment can cause the firing mechanism to decock on bolt opening.

Figure 111- Shows a cutaway **Kepplinger** single set trigger installed on an M98 receiver. This trigger sets by pushing the trigger forward. If the safety lever is moved, or the bolt is opened after the trigger has been set, the mechanism responds to the change in cocking piece pressure by unsetting the trigger and returning it to normal pull.

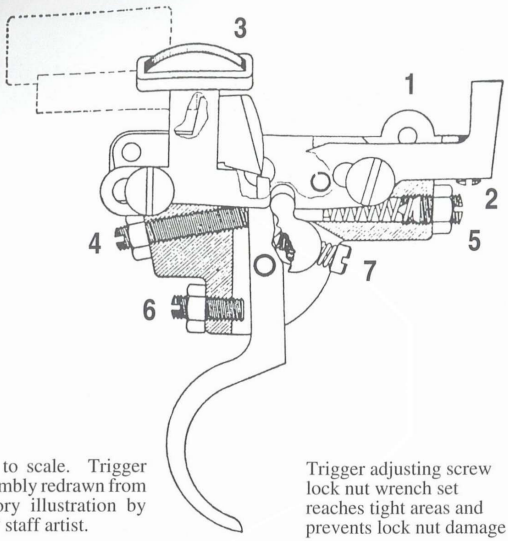
About Set Triggers-

Set triggers have been quite popular in European sporting rifles since the early 1800's.

A correctly installed and well adjusted set trigger can offer a workable solution to the accidental discharge problem that lurks in some hunting and sporting rifles that have lightened trigger or sear springs and too light trigger pull.

Rifles with set triggers can be carried in the field with triggers unset. Unset pull in most set triggers is usually about 3 to 4 lbs. This is quite good enough for a fast shot. Many set triggers can be adjusted to well below 1/2 lb. pull. When ready for use, the set trigger can be engaged to reduce pull for more precise shots. Another advantage with set triggers is that sear springs can be kept at full strength. Firing pin spring pressure also can be increased from the original factory 19 lbs. to 22-26 lbs. for more positive ignition, without seriously affecting trigger pull.

Double set triggers usually mount on the trigger guard and require a considerable amount of careful fitting. Most use the original military sear body and sear spring. A modified trigger, used as a sear kick off lever, cams the military sear down to release the firing mechanism. Currently available M98 double set triggers can't be installed on M91's. The trigger/sear/bolt safety interlock system should not be altered or removed when a double set trigger is installed on an M92~M96 action. The Kepplinger M98 single set trigger, shown in figure 111, was designed strictly for use in M98 actions and installs in place of the entire M98 military trigger/sear assembly. This trigger will not function correctly in earlier Mauser models. Single and double set triggers available from Brownells Inc.



Not to scale. Trigger assembly redrawn from factory illustration by VSP staff artist.



Trigger adjusting screw lock nut wrench set reaches tight areas and prevents lock nut damage

Figure 112- Sectional illustration shows adjustable trigger commonly used on ZCZ Yugoslavian manufactured Mark X and Whitworth commercial M98 Mauser actions imported by Interarms.

Before Adjusting Trigger:

1. Make sure the trigger receiver mounting pin is correct and fits snugly.

2. Make sure the receiver mounting screw at the front of the trigger is tight. A loose mounting screw can cause erratic sear releases and/or slam or impact fires.

3. Cock and close the bolt. The safety adjustment screw must be backed off prior to trigger adjustment to prevent safety screw tip damage or interference with the trigger.

Adjust Trigger as Follows:

4. **Adjust trigger/sear engagement**- this adjustment is made to lessen or remove creep. Loosen the lock nut on the trigger/sear engagement adjusting screw. Adjust trigger/sear engagement and check by viewing through the inspection port on the left side of the trigger body. Trigger and sear engagement must be enough to prevent impact fires or slam fires, and in no case less than about .020". See page 98. When final adjustment is reached, hold screw position and tighten the lock nut.

5. **Adjust trigger pull**- loosen the lock nut on the trigger tension screw. Adjust tension to the desired trigger pull weight. Range of adjustment in triggers of this type in serviceable condition is 3 to 5 lbs. However, I suggest maintaining at least a 4 lb. pull in hunting rifles. Hold tension adjustment setting with a screwdriver while tightening the lock nut.

6. **Adjust trigger overtravel (backlash)**- loosen the lock nut on the travel limiting screw. Adjust the limiting screw until the trigger will move just enough to release the sear and firing mechanism without sear edge drag. Then recock the bolt while viewing through the inspection port at the left side of the trigger. If the sear drags or is blocked by the trigger, back off the travel limiting screw until the sear just clears the trigger without drag as the bolt is cocked. Hold travel adjusting screw position with screwdriver and tighten the lock nut.

7. **Adjust safety**- cock the bolt and pull the safety lever to the rear to place the safety in the on position. Adjust the safety screw slowly, until the stop at the end of the screw contacts the trigger and blocks trigger movement. Then function check the safety. With the safety on, the bolt lock stud must prevent the bolt from opening; the safety lever must cam the safety screw into trigger block position; and the trigger must not release the sear. Impact must not cause sear release. See slam fire and impact fire warnings on page 98.

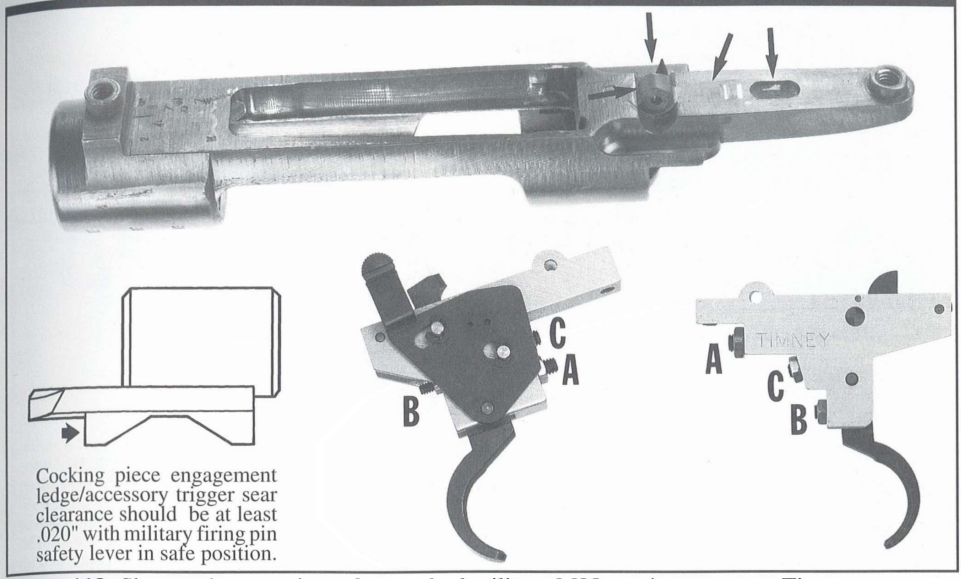


Figure 113- Shows a bottom view of a standard military M98 receiver, at top. Timney accessory triggers are shown, below. Receiver check points for installation of adjustable accessory triggers are indicated above and discussed below. Always consult manufacturer's instructions before installing accessory triggers.

1. **Mounting pin hole** (same as military sear pivot pin hole)- should not be oversize. If correct size pin is loose, drill and install next larger diameter pin.

2. **Receiver sear pivot pin stud** - must not be so long that it causes mounting pin bind or damage to the trigger body. Adjust receiver pivot pin stud length with a file if too long.

3. **Receiver sear port**- if the sear catches inside the port or will not depress, mill the front of the port slightly forward (just enough for sear clearance).

4. **Bottom of receiver in trigger contact area**- level high spots with a medium stone to prevent interference with trigger body.

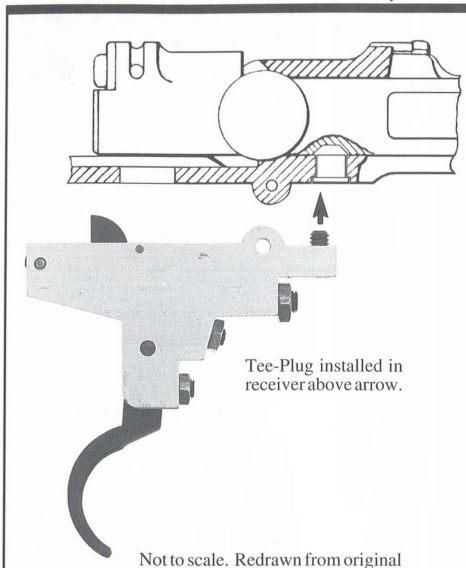
The Timney Sportsman (SP Series) M98 Mauser adjustable trigger, shown at right, must be used with an M98 military type bolt sleeve and firing pin safety system installed. Sportsman series trigger pull is adjustable in the 2 to 4 lb. range. Pull is adjusted at set screw at **A**. Trigger/trigger sear engagement and creep are adjusted at set screw **B**. Trigger overtravel (backlash) is adjusted at set screw **C**.

Timney Featherweight triggers are available with or without the side mounted safety shown. The Featherweight Deluxe (FD Series) M98 trigger, at left, has a side mounted safety lever and built-in trigger block safety system. This trigger can be used with a streamlined commercial bolt sleeve or military bolt sleeve with firing pin safety lever. Featherweight series trigger pull adjusts in the 1 to 3 lb. range. Pull is adjusted at set screw **A**. Trigger/trigger sear engagement and creep is adjusted at set screw **B**. Trigger overtravel (backlash) is adjusted at set screw **C**. Adjusting screw position is held after each adjustment while the lock nuts are tightened.

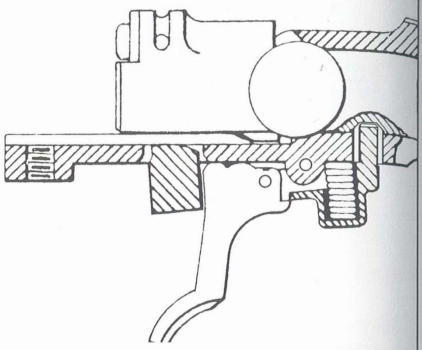
The trigger levers on the triggers shown fit 2" trigger guards. A shorter 1 3/4" version is made for receivers with smaller guards.

An added advantage with triggers of this type is that 22-26 lb. firing pin springs can be installed to improve ignition, without seriously affecting trigger pull.

Each installation must be considered individual, although some accessory triggers will almost drop in. Clearance receiver sear ports only as needed. When used in hunting rifles, I suggest setting accessory triggers at 3 to 4 lbs. with minimum creep and overtravel. If trigger adjustment underengages the sear, (depending on backlash adjustment) the sear may slip or bounce off on impact. If the overtravel (backlash) screw is overadjusted, the trigger can block the sear. Always check for correct trigger function after installation and for possible safety-off fires and slam and/or impact sear releases.



Not to scale. Redrawn from original illustrations by VSP staff artist.

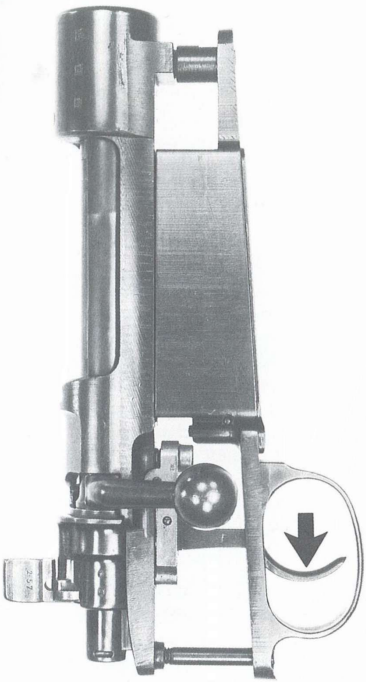


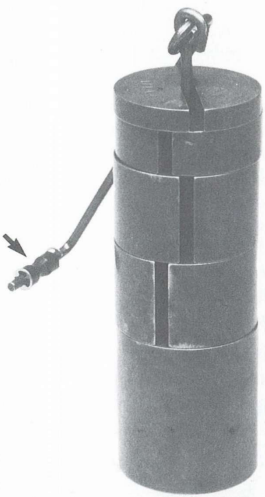
To create a positive bearing point for the trigger installation screw and to prevent possible accessory trigger loosening problems, the trigger/sear/bolt safety port in an M92~M96 receiver can be filled with an easily made mild steel T-shaped plug, as illustrated above. The receiver port is lightly counterbored to receive the plug. The finished plug is then staked and sweated in position with Hi-Force 44 Solder. This low temperature solder melts at 475° F but does not dissolve in hot oxide bluing tanks.

Figure 114- Sectional illustration, at top right, shows the trigger/sear/bolt safety interlock system that was standard throughout production of the Mauser M92 through M96 military action models. This system was designed to prevent firing pin release until the bolt was fully closed and locked. Although this was a useful feature in a combat situation, other rifle makers, including the manufacturers of civilian bolt action sporting rifles, have not considered this safety system necessary. Nonetheless, removing an M92~M96 military trigger to install an adjustable sporting trigger, which are not made with trigger/sear/bolt safety interlocks, falls under the category of removing an original factory safety system and is not recommended. However conservative or technical this point might seem, the fact that a safety system had been removed could be used in a liability suit in the event of an accidental discharge and resulting injury. That the accident actually might have been caused by an individual carrying the rifle loaded, with safety off and finger on the trigger, might not make any difference. Keep this in mind when installing custom triggers on any rifle.

Mauser M92~M96 action dimensions vary to some extent between the models. Individual variations are particularly noticeable in Spanish made M93 and M95 receivers. Some receivers have stepped and thicker bottoms which can cause accessory trigger sear/cocking piece engagement problems unless a taller accessory trigger sear is used or the high area is milled lower. Another problem is that the installation screw in some accessory triggers is located close to, or lines up with, the edge of M92~M96 receiver trigger/sear/bolt safety interlock ports. In some cases, when tightened, the installation screw can seat into or push away the corner of the port. If left this way, the trigger assembly may loosen and permit the sear to drop. There are several possible results if this happens, including: erratic sear releases, slam fires, impact fires, etc. If you decide to install a custom trigger on an M92~M96 action, a solution to this problem is shown and discussed above.

M98 actions have an internal bolt/firing pin safety interlock system which does not involve the trigger mechanism, and are exempt from the above. Combine this feature with the fact that M98 bolts cock on opening; that M98 actions have better gas porting; that large ring M98 receivers have greater barrel thread area and are much stronger overall, and you have five practical reasons in favor of using only M98 actions when building quality custom sporting rifles.





Factory adjustable triggers and accessory adjustable triggers must not be set below factory minimum pull specification. Two stage military triggers and commercial single stage triggers of the type shown in figure 109 should not be adjusted or set below 4 lbs.

The roller on the trigger weight arm centers pull weight on the trigger lever when the action is in the vertical position.

Warning: The firing mechanism must not release until the trigger is pulled. Do not fail to recheck actions for slam fires, impact fires, and/or safety-off fires after trigger installation or trigger adjustment.
See figures 112 -117.

Figure 115- Shows NRA type trigger weights used for checking trigger pull. This system can't produce a false reading and is particularly useful for fine tuning adjustable triggers. When the trigger is preloaded with weights in the required pull range, a light tap on the receiver will usually release the sear at about 1/8 to 1/4 lb. before the actual pressure release point. NRA type trigger weights available from **Brownells, Inc.**

Check Trigger Pull

The sear spring accounts for about 70% of trigger pull weight in Mauser military actions. Sear/cocking piece engagement and firing pin spring loading accounts for the rest. Abnormal trigger stiffness and creep can be caused by soft, galled, pitted, or rough sear and cocking piece engagement surfaces, trigger lever and cam problems, and trigger/ sear pivot pin problems.

Military sear and cocking piece engagement surfaces can be lightly polished with a fine stone to lessen creep, providing the case hardening is not cut through; surfaces are not rounded off; and the 90° sear/cocking piece engagement is not changed.

If the sear spring is replaced with an accessory spring of lower tension, check to make sure that the firing mechanism does not slam fire or impact fire.

Two stage military triggers and early commercial single stage triggers shouldn't be adjusted below 4 lbs. Adjustable Mark X Mauser sporter triggers should not be adjusted below 3 1/2 lbs.

About Safe Triggers-

Over the years, a wide variety of adjustable accessory triggers have been made for Mauser actions. Many of these triggers have minimum pull specifications in the 1 or 2 lb. range, or less. Light trigger pull settings are particularly beneficial in tuned bench and varmint rifles when used under controlled conditions. Trigger pull must never be set below manufacturers minimum specification.

Keep in mind that minimum pull specification is not a recommendation for any category of use. Adjustable triggers on hunting rifles, for example, should not be set below 3 1/2 lbs. Lighter trigger pull is potentially hazardous under field conditions. A safe trigger is defined as one with pull within the standard 3 1/2 to 5 lb. range in an action that does not slam fire, impact fire, or safety off fire.

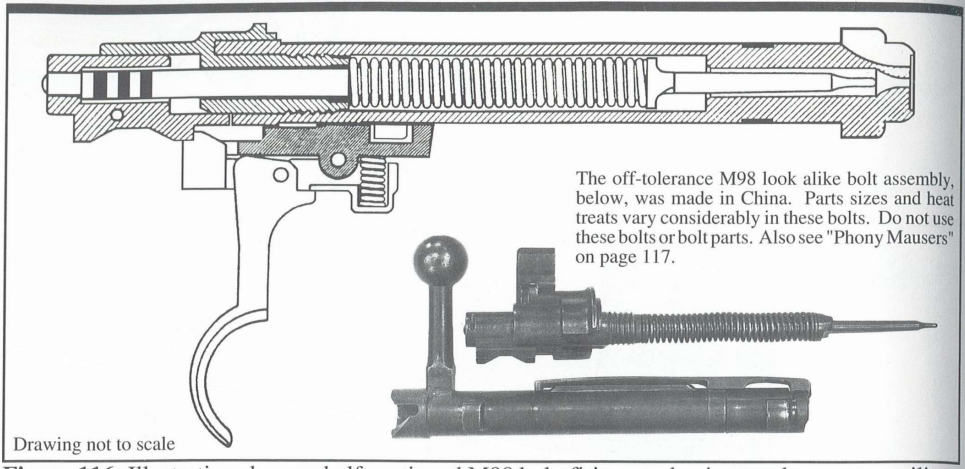


Figure 116- Illustration shows a half-sectioned M98 bolt, firing mechanism, and two stage military type trigger/sear assembly. Possible causes of slam and/or impact fires are listed below. Although some of the causes listed are more likely than others- all, or a combination, could cause the firing mechanism to release without the trigger being pulled. Serviceable Mauser actions do not slam fire or impact fire. Test for slam and impact fires by fast cycling the action with dummy cartridges and then by striking the receiver sharply with a rubber hammer.

Slam fires: are usually caused by weak springs and/or insufficient sear/cocking piece ledge vertical engagement- but could be caused by any of the items listed below. Slam fires occur when the bolt is cycled and closed rapidly, or closed with force, and the cocking piece engagement ledge climbs over and bypasses the sear. The bolt then decocks on closing, extending the firing pin. A chambered round would fire as the bolt is closed if firing pin protrusion is long enough to ignite the primer.

Impact fires: in this case, the sear engages and retains the cocking piece and firing mechanism and permits the bolt to be closed normallywithout decocking. In actions that will impact fire, sear/cocking piece engagement is interrupted and released in the event the rifle or action is bumped or otherwise impacted after the bolt is closed. In this case, a chambered round would also fire.

Safety-off fires: are almost always caused by cocking piece alteration in an attempt to solve a receiver/bolt/firing mechanism minus tolerance accumulation which makes the safety lever stiff or inoperative. Test for safety-off fires with the rifle unloaded. Cycle, cock and close the bolt, and place the firing pin safety lever in the safe position. Then, pull the trigger. If the cocking piece clicks, or moves forward (the trigger is usually slack at this time) the cocking piece engagement ledge has just slipped past the sear. With the cocking piece in this position, the safety lever now takes the place of the sear. If the safety is then moved to the off position, it will release the firing mechanism. If a round was chambered, it would fire. In rifles that have both safety-off and impact firing problems, impact fires are sometimes delayed until the safety lever is moved to the off position.

Possible Causes of Slam Fires and Impact Fires:

1. **Insufficient sear engagement**- caused by low sear rest position, or a worn, altered, damaged, or incorrect sear. Low sear rest position also can be caused by a trigger with a high first stage cam.

2. **Insufficient cocking piece engagement**- caused by a worn, altered, or damaged cocking piece engagement ledge.

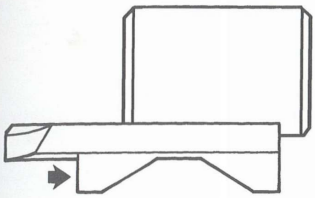
3. **Sear bypass, sear bounce, or sear deflection**- is usually caused by weak or incorrect sear and firing pin springs; an incorrect or altered sear; an incorrect or altered trigger; a loose sear pivot pin; oversized pivot pin holes; by numbers **1** or **2**, above, or any combination.

4. **Loose bolt (rare)**- caused by an altered or incorrect bolt. See "Phony Mausers" on page 117.

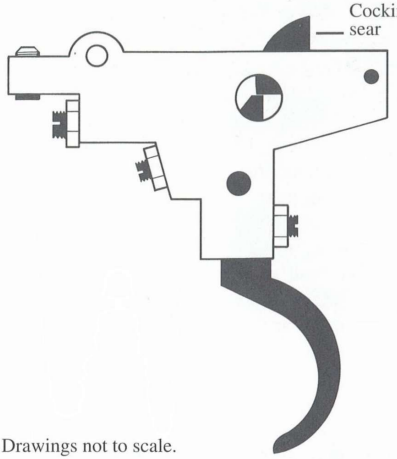
5. **Loose bolt sleeve/bolt assembly thread joint**- caused by rust undersized, altered, mismatched, or off-tolerance parts. See "Phony Mausers" on page 117.

6. **Loose cocking piece/bolt sleeve**- caused by off-tolerance parts.

7. **Trigger/sear assembly drag or bind**- can be caused by a rusted or dirt impacted trigger/sear assembly; a bent or incorrect trigger lever; an incorrect trigger guard; and damaged, rusted or incorrect trigger/sear pivot pins.



Minimum clearance of .020" between the cocking piece engagement ledge and trigger cocking piece sear must be present when military bolt sleeve/firing pin safety lever assemblies are used with accessory triggers. If clearance is below .020", adjust cocking piece engagement ledge, polish, and reharden.



Drawings not to scale.

Figure 117- Generic trigger illustration depicts an accessory three way adjustable trigger. Most adjustable accessory triggers are well made and virtually trouble free. Problems with these triggers are almost always the result of improper installation; improper adjustment; damage during repair, and parts substitutions or missing parts. When inspecting and servicing actions with previously installed accessory triggers, it can't be taken for granted that the triggers are serviceable or have been correctly adjusted. Problems with accessory triggers usually group in the following categories:

A. The trigger's internal sear slips off

1. The trigger is misadjusted- not enough sear engagement and/or trigger tension.
2. The trigger won't hold adjustment- tensioning screw, lock nut, and/or trigger body threads are damaged; a weak tension spring or wrong parts are installed; and/or the trigger or internal trigger sear engagement surfaces are altered or damaged.
3. Trigger pivot and assembly pins are altered, damaged, or incorrect substitutions.

B. Trigger cocking piece sear does not positively engage and hold the cocking piece

1. The trigger assembly is grossly misadjusted.
2. Trigger cocking piece sear vertical position and cocking piece engagement is low- cocking piece sear is too short for receiver dimensions.
3. Trigger cocking piece sear vertical position and cocking piece engagement is low- the installation/tightening screw in the trigger body is misadjusted or loose. The installation screw or trigger body threads are damaged; the trigger body installation pin or pin holes are altered or damaged; also, the installation screw may not have a positive receiver surface to engage- see figure 114.
4. Sear surfaces or trigger engagement surface altered or damaged.
5. The internal sear is not fully engaged by the trigger (or the trigger does not engage the sear at all)- the trigger lever is too long or bent, and drags or sticks in the trigger guard or trigger window.
6. Trigger pivot and assembly pins are altered, damaged, or incorrect substitutions.

C. Safety system malfunctions

1. The trigger block safety stop is incorrectly adjusted. Consult manufacturer's instructions.
2. The trigger block safety parts are altered, damaged, or incorrect substitutions.
3. Safety-off fires (actions with military bolt sleeve and firing pin safety lever assembly)- the trigger cocking piece engagement sear does not permit .020" cocking piece engagement ledge clearance with the firing pin safety lever in safe position.
4. Safety-off fires (actions with military bolt sleeve and firing pin safety lever assembly)- this problem can be caused when a cocking piece has been altered in an attempt to remedy a minus tolerance accumulation problem that would make a safety lever stiff or inoperative. See pgs. 51 & 98.

D. The trigger cocking piece sear is erratic, sticks, or won't release the cocking piece

1. Trigger overtravel has been misadjusted. The trigger's internal sear does not have enough clearance for smooth release or cannot fully release.
2. The trigger cocking piece sear drags inside the receiver sear port.
3. The trigger cocking piece sear catches on, or stops against, the sear port.
4. The trigger assembly and pivot pins are altered, damaged, or incorrect substitutions.

About M91~M96 Bolt Cock-on-Opening Conversions-

As far as workmanship is concerned, several of the M93 and later model bolt cock-on-opening conversions I've seen have been quite well done. In the best of these conversions, the replacement cocking piece (1035 steel) was polished and case hardened to approx. C50 to minimize galling at the bolt's newly cut full cock ramp. However, even when superbly done, there are several serious potential problems with the end product of this modification, and a number of reasons not to do it:

1. The bolt cocking ramp bearing surface on M91~M96 bolt bodies is much too narrow to distribute the load placed on it by a modified or custom full cock M93 type, or later, cocking piece.
2. In an M91~M96 action that is used to any extent, cocking piece/ramp loading usually results in galling and excess cocking surface wear. In designing the M98, Mauser redesigned and upsized the cocking piece and bolt cocking ramp area for this specific reason. See figs. 118 and 119.
3. Bolt assembly threads are located at the very back of M91~M96 bolt bodies. Enlarging the cocking ramp and notching it forward cuts through M91~M96 bolt assembly threads and weakens the bolt body.
4. Cutting M91~M96 bolt bodies through the assembly threads can create bolt sleeve/cocking piece play in some bolts. This can affect sear engagement.
5. These conversions require replacement of the original military trigger with an accessory trigger.
6. Surface wear on a modified bolt cocking ramp could make later bolt body replacement necessary. Because bolt body replacement affects headspace, the barrel may also require requalification or replacement.
7. Modified M93 type firing mechanisms must be installed in M91 bolts in order to make cock-on-opening conversions work in M91 actions.
8. Considering the limited benefit gained and the time and cost involved, I don't believe these conversions are worth the effort.

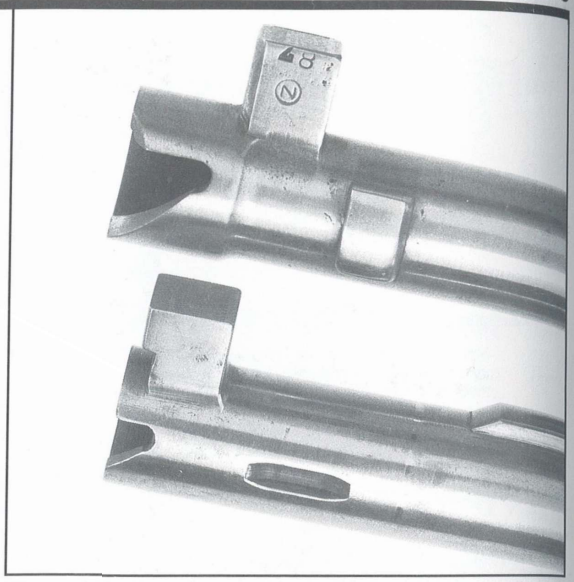
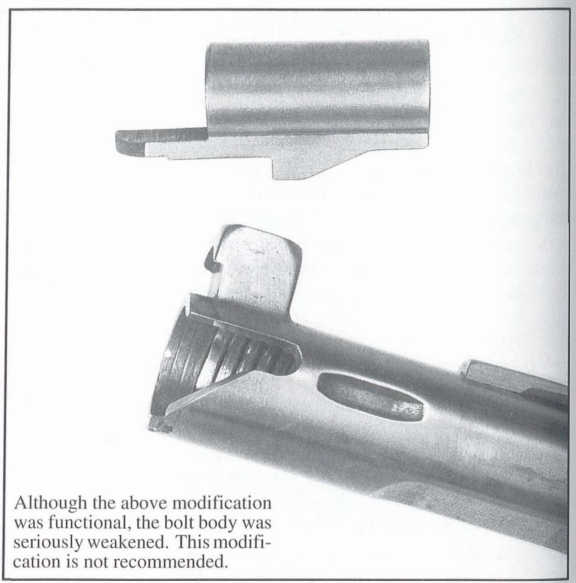
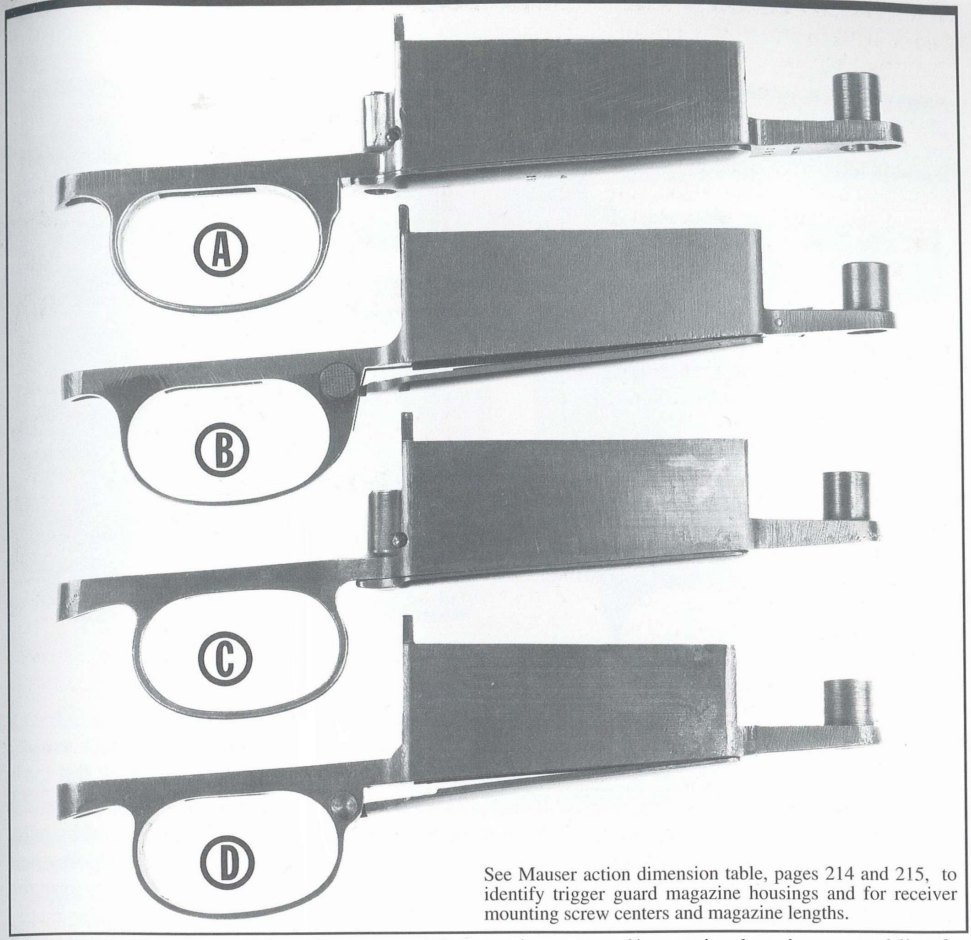


Figure 118- Shows an unaltered 1/4 cock ramp on a Mauser M94/M96 type bolt and the full cock ramp on an M98 bolt for comparison. The M98's were the first Mausers to cock on opening. To do this without galling or premature cocking ramp wear, rear bolt diameter and cocking ramp width were stepped up to provide a wide, spiral cut bearing surface.



Although the above modification was functional, the bolt body was seriously weakened. This modification is not recommended.

Figure 119- Shows a custom made M93~M96 cock-on-opening cocking piece, at top. The Mauser M95 bolt, below, was altered in an attempt to duplicate M98 spiral cocking ramp dimensions. The factory quarter cock ramp has been oversized and cut forward through the bolt assembly threads to make the above cocking piece function with the M95 bolt.



See Mauser action dimension table, pages 214 and 215, to identify trigger guard magazine housings and for receiver mounting screw centers and magazine lengths.

Figure 120- Shows examples of common Mauser trigger guard/magazine housing assemblies for comparison. The M98K trigger guard/magazine housing, at **A**, has a standard, plunger retained, removable magazine floorplate. To remove this style floorplate, depress the release plunger and push the floorplate back toward the trigger guard until it disconnects. Military floorplate retaining plunger and spring assemblies are secured with a crosspin which is removable from either side of the housing.

The late commercial M98 trigger guard/magazine housing with hinged floorplate, at **B,** resembles an early Oberndorf style commercial trigger guard housing, but has a side mounted floorplate release button. Other commercial trigger guards have release levers inside the trigger guard, see figure 109, which are retained by a pivot pin through the side of the trigger guard. Earlier commercial lever release mechanisms are mounted forward on the floorplate assembly. See illustrations in figures 108 and 110.

The M94/M96 Swedish Mauser trigger guard/magazine housing, at **C**, is similar to the M98 military, but shorter. M93/M95 Spanish trigger guard/magazine housings are also similar but are even shorter than the M94/M96. Standard M93~M96 floorplates remove in the same way as the M98.

The M93 Spanish short rifle trigger guard/magazine housing, shown at **D**, has a hinged floorplate and recessed trigger guard mounted floorplate release button. A cartridge tip was usually used to depress the floorplate release button. These trigger guard/magazine assemblies have been mixed downstream and can be found on M93, M94 (non-Spanish) and M95 actions, and also on M1916 conversions.

Hinged floorplate catch mechanisms are easily removed for cleaning and trigger guard refinishing. Staked spring catches, such as the Mark X, should only be disassembled to replace parts. Do not remove staked release mechanisms from trigger guards that are to be reblued. Bluing salts residue is removed by placing the trigger guard in a bleed out neutralizing solution after the hot oxide bath.

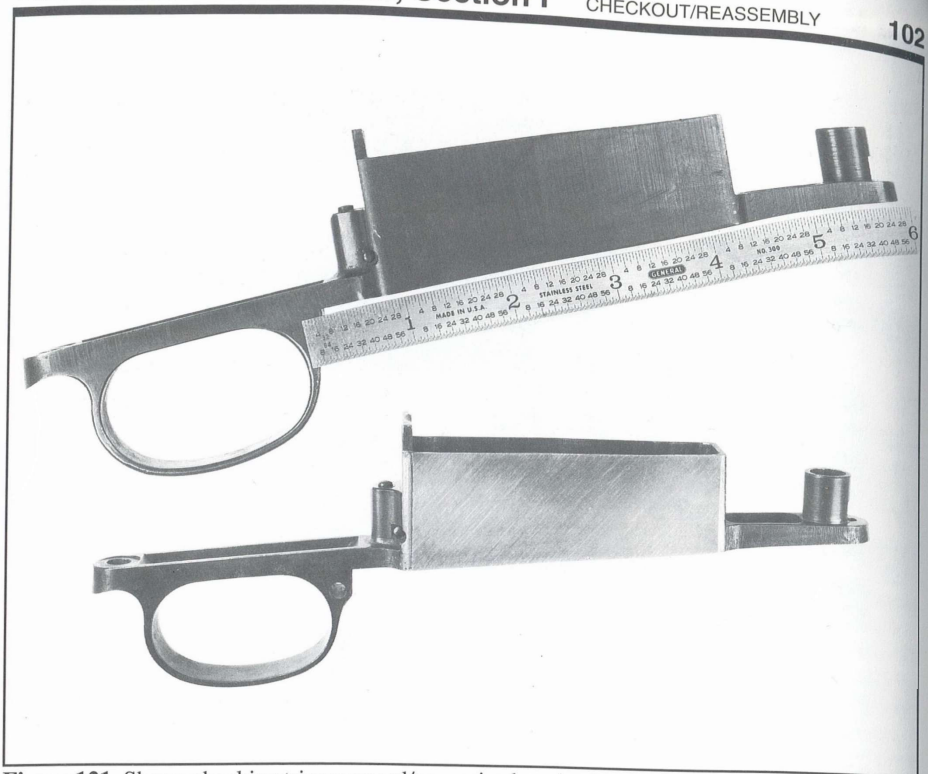


Figure 121- Shows checking trigger guard/magazine housing bottom straightness against a metal scale, at top. Rust pits in the trigger guard/magazine housing, below, have been repaired by MIG welding and resurfacing the sides of the magazine well. Mauser M93~M98 trigger guard housings are relatively soft and can be bent by careless removal (usually by jerking or prying the trigger guard out of the stock). Most slightly bent trigger guard housings can be easily straightened by securing the solid parts of the housing in a bench vise between soft aluminum blocks and tapping or rebending distorted areas back to shape.

Trigger guard housings that are more than slightly bent tend to stretch and can be difficult to straighten without heating and shrinking stretched areas. Sometimes, after a stretched trigger guard housing has been straightened, the distance between mounting screw hole centers will be found to have increased enough to place assembly screw alignment slightly off center. In some cases, slightly enlarging the receiver mounting screw holes will remedy this problem. In severe cases, the housing will have to be sectioned and welded or replaced.

Dented or bent trigger guard bows can be straightened by placing the indented or off contour area over a mandrel and peening the exterior to the desired contour with a brass hammer.

Shallow pitted areas in trigger guard/magazine housings can be cleaned and low current MIG welded. A copper magazine well insert helps control heat and warpage. After welding, flat areas are easily hand filed or fly cut to original contour. Curved surfaces can be hand detailed with a file. Flat sides are then finished with sandcloth on a surface block. Although this method is time consuming, it is useful in restoring guard housings in collectable matching number rifles and less expensive than installing a custom replacement in a sporting rifle.

Welding repairs are usually visible after hot bluing. With this in mind, I suggest sandblasting magazine wells that are to be oxide blued or using the hot water accelerated rust bluing method. See pages 207 through 211.

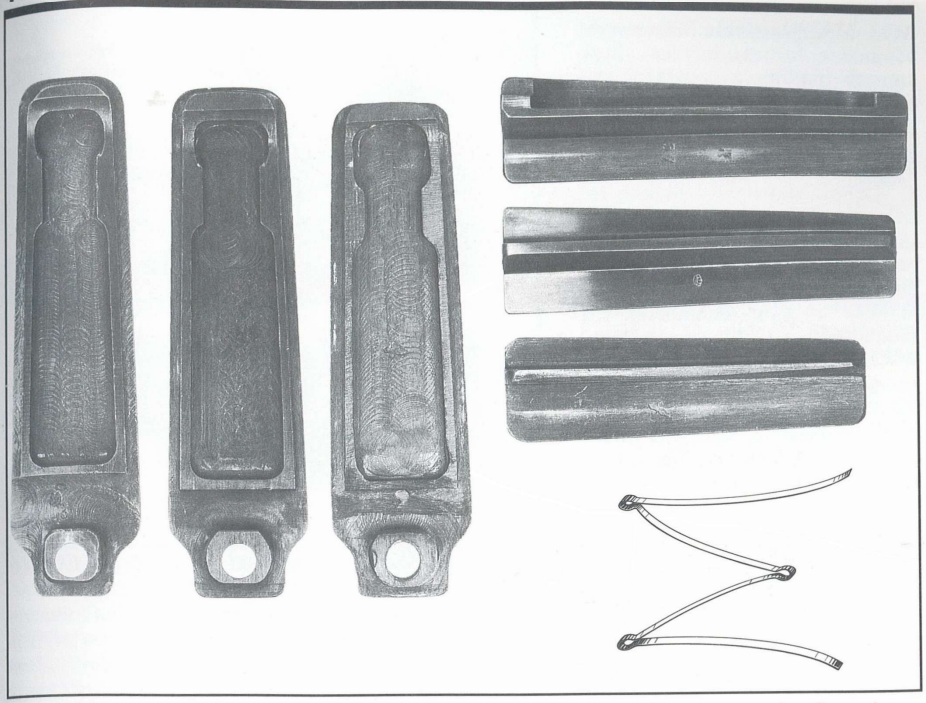


Figure 122- Shows M98, M94/M96 Swedish, and M93/M95 Spanish type magazine floorplates, from left to right, for identification and comparison. From top to bottom, M98, M94/M96, and M93/M95 type magazine followers are also shown for comparison.

Magazine floorplates in the above model groups are slightly different in shape and length and do not interchange.

The M98 type magazine follower is different than the M94/M96 and earlier followers in that it has vertical travel stop extensions on the left side to position it lower inside the magazine well. The lower position minimizes drag when the bolt is cycled when the magazine is empty. For this reason, M98 magazine followers are sometimes found modified, to one extent or another, and installed in earlier Mauser actions.

Military M98 magazine followers are found with slightly different cartridge guide rib widths and rib angles (see photos in figures 124 and 244) to accommodate 7x57mm, 8x57mm, and 7.65x53mm cartridges. By now, M98 magazine followers have been mixed up downstream so completely that any follower could be found in any M98 action. M98K's, see the example at top, typically have a slot cut in the rear travel stop extension. Magazine followers that are rough, too wide overall, or that have a too wide cartridge guide rib (for the cartridge in the magazine) can drag or stick in the magazine well when one, or more, cartridges are in the magazine. Although M98 magazine design is surprisingly forgiving, followers with wide guide ribs can sometimes cause feeding problems. Magazine followers made for late commercial M98 actions vary with action size. Early Oberndorf commercial actions typically had magazine followers that were precisely machined to feed the specific cartridge the actions were ordered for.

Original magazine follower springs are slightly different for the above models. The M98 spring, see illustration above, is longer and has more vertical lift. Because M98 follower springs were commonly available, they are often found modified and installed as replacements in M94/M96 and M93/M95 models. This is a workable substitution providing the altered spring ends are wide enough to stay engaged in the retaining key slots machined into the floorplate and magazine follower. Spring ends must be long enough to prevent the spring from backing out of the engagement detent in the follower and floorplate unless pulled up and disengaged by hand.

M93~M98 Magazine Followers

Magazine followers must allow smooth loading and permit cartridges to be stripped forward from the magazine with only light drag against the receiver magazine rails. Prepare and check as follows:

1. Deburr and lightly smooth receiver magazine rail edges with #400 sandcloth- but do not oversize the magazine opening Rear magazine rail opening should not exceed .590" to .600" in rifles chambered for standard rimless military cartridges.
2. Temporarily install the trigger guard/magazine assembly and snug the receiver mounting screws.
3. Place a dummy cartridge of the correct type for the barrelled action on the magazine follower and push down slowly. The follower should deflect with little drag as the magazine receives the cartridge.
4. If the left edge of the follower drags or binds on the magazine well, deburr and polish the edges and corners of the follower.
5. If the follower is still resistant in M93~M96 models using standard military cartridges, the right magazine rail bottom corner could be rough or sharp or the left side of the follower guide rib could be too wide.

Note: Receiver magazine rail openings are tight on some M93 and M95 models. If rail opening is less than .585", and the follower hits the left magazine rail or drags in the magazine well as the first cartridge is pushed down, polish the parallel rail opening to .590" and recheck. Follower guide ribs are sometimes slightly wide in M93~M95 models. If loading is still resistant after rail polishing, clearance the left side of the rib until loading is normal.

6. If an M98 follower drags or binds on the magazine well after edge polishing, select a replacement M98 follower with a thinner cartridge guide rib.

Note: Magazine rails usually do not need further adjustment except in barrelled actions chambered for larger than original cartridges. Longer or larger diameter cartridges and cartridges that are larger in diameter at the shoulder usually require magazine box modification, as discussed in Section II.

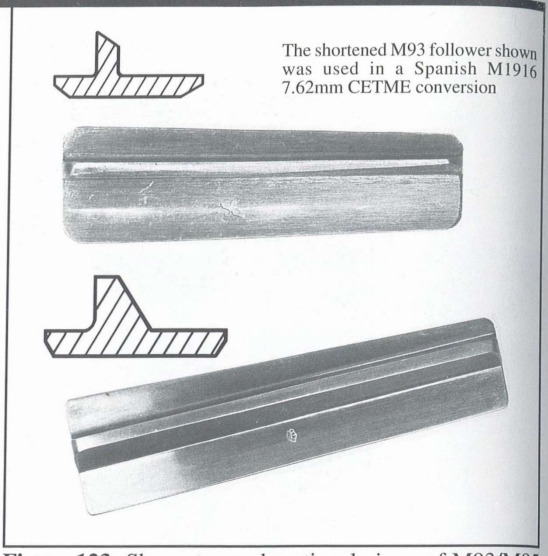


Figure 123- Shows top and sectional views of M93/M95 Spanish type and M94/M96 Swedish type magazine followers. The standing cartridge guide rib on these followers stops the bolt on an empty magazine. Cartridges larger in shoulder diameter than the 7x57mm (such as the 7.62mm CETME) can cause the left side of an M93/M95 follower to drag or bind in the magazine well in M93 and M95 actions.

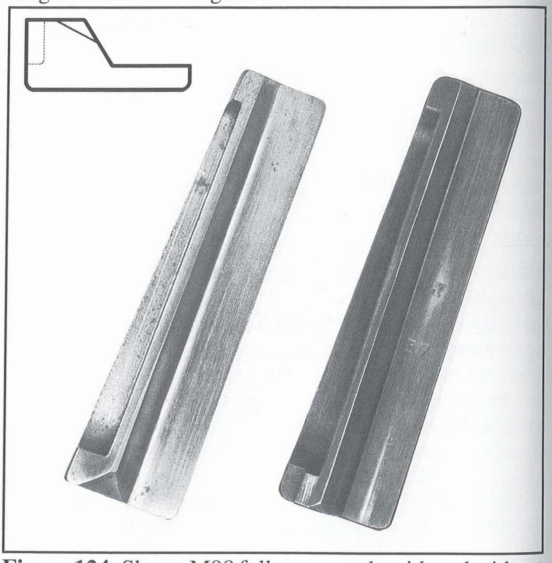


Figure 124- Shows M98 followers made with and without the optional bolt cycling bevel. The bevel deflects the follower and permits the bolt to close on an empty magazine. Vertical travel stops on the left side hold M98 followers lower and minimize bolt follower drag when the magazine is unloaded. The angled cartridge guide rib makes loading smoother and also helps to minimize bolt body drag.

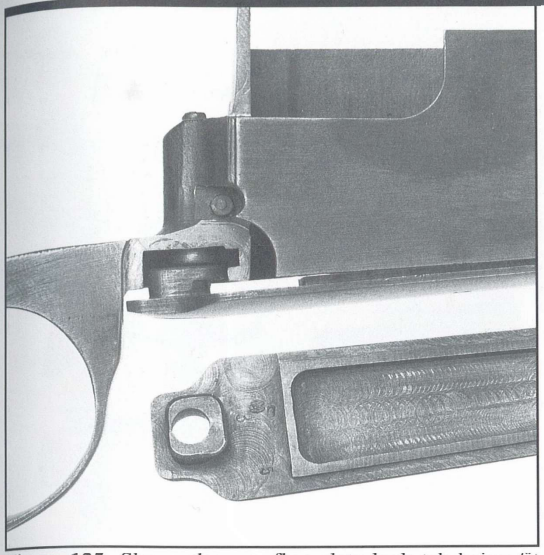


Figure 125- Shows the rear floorplate lock tab being fit checked in a cutaway M98 military trigger guard/magazine housing. The lock plunger should engage when the floorplate is all the way forward and both the front and rear lock tabs have engaged in the magazine well tab slots. Floorplates can be hard to install or remove when lock tabs are nicked or damaged or when magazine well tab slots are dirt impacted.

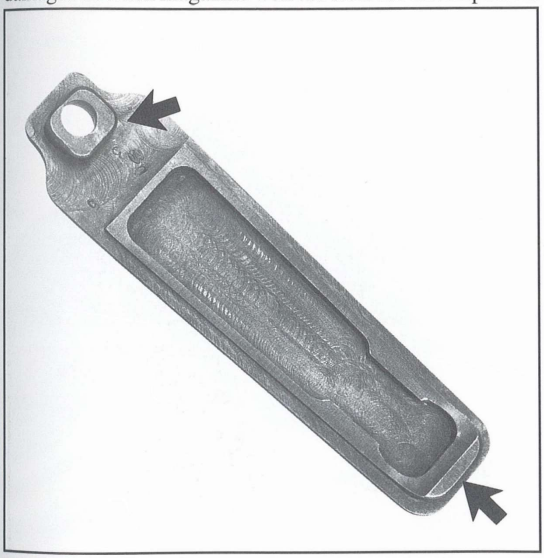


Figure 126- Shows front and rear lock tabs on an M98 floorplate. Floorplate fit is loosened when the bottom of a trigger guard/magazine housing is resurfaced. Lock tabs can be adjusted to correct magazine fit by dimpling. Insert a steel gauge strip between the floorplate and tab to control closure. Place floorplate on an aluminum block to prevent damage.

Hard to Install Floorplates

Floorplate lock tab engagement recesses, tab slots, and floorplate release plunger tunnels in M93~M98 military trigger guard/magazine housings can become impacted with dried oil and dirt. This accumulation can make floorplate removal and installation difficult.

Tight Floorplates

Floorplate lock tabs that are nicked or damaged can be hard to remove or install. Floorplate lock tabs that have been adjusted to fit a specific trigger guard/magazine housing can be hard to remove if installed on the wrong housing. If floorplate fit is too tight, carefully clearance the lock tab with a small barrette file.

Loose Floorplates

Resurfacing the bottom of the magazine housing will loosen floorplate fit. Refit loose magazine floorplates as follows:

1. Measure the gap between the lock tab and the floorplate.
2. Measure the distance from the bottom of the magazine well to the top of the floorplate lock tab slot.
3. Subtract measurement #2 from #1 to determine correct tab height.
4. Install a gauge strip under the floorplate lock tab that is about .002"-.003" thicker than the correct tab height found in #3, above.
5. Place the floorplate on an aluminum block and dimple the lock tab in two places with a center punch. Indent until gauge strip drags lightly.
6. Recheck fit. If still loose, dimple with thinner gauge strips until the desired clearance has been reached.

Note: Tighten the front lock tab in the same way. Use extra caution to prevent bending the floorplate.

7. If the floorplate is slightly tight after adjustment, clearance the lock tab with a barrette file.

Hinged Floorplate Lock Tab

In most cases, the easiest way to repair a worn hinged floorplate catch or lock tab is to carefully peen and stretch the floorplate tab until the catch will hold. Otherwise, building up and/or filing the catch engagement deeper is needed.

About M93~M98 Ejector Boxes, Box Springs, and Ejectors-

M93~M98 ejector box springs need not be removed unless dirt/oil impacted, damaged, or the ejector box assembly is to be reblued. See page 65 for ejector box disassembly.

M93~M98 ejector arms are easily removed for inspection by pulling the arm forward and out of the ejector box after the pivot screw has been removed.

Spanish made M93 and M95 ejectors tend to vary both in material thickness and quality of heat treat. These ejector arms bend and break easier than other models.

M94/M96 ejector arms are slightly thicker and more consistently heat treated and can be retrofit as replacements back through the M91 model. Very little fitting is usually needed.

M98 ejector arms have been made with either round or elongated pivot holes. See figure 127. Both types will interchange.

A light 45° chamfer on the forward corners of an M98 ejector arm helps to make passage through the bolt ejector slot smoother. This also prevents the ejector arm from catching on the back of the bolt.

Check Ejector Arm Length

1. M98 bolts- draw the bolt back and hold firmly against the bolt stop. The 90° forward edge of the ejector arm should be approx. flush with the ejector extension on the left side of the bolt. Replace the ejector if shorter.
2. M91~M96 bolts- draw the bolt back as above. The angled forward edge of the ejector arm should extend a minimum of approx. .290" ahead of the bolt face.

Install Ejector Box Assembly

Install as shown in figure 128.

Caution: Both pivot screw and ejector box threads can be damaged if the pivot is bent or the ejector is misaligned. If threads are resistant, recheck the pivot screw and realign the ejector arm and box.

M91 Ejector Boxes

Reassembly and installation is the reverse of the disassembly procedure on page 65.

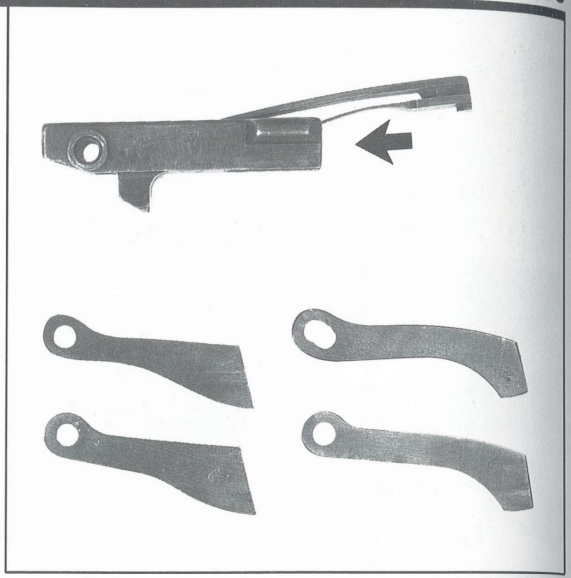


Figure 127- Shows the ejector box spring being installed in an M98 ejector box, at top. Ejector box springs are removed for ejector box cleaning, replacement, or rebluing. M94/M96 and M93/M95 ejector arms are shown below, at left. A German made M98 ejector arm (the pivot hole is oval) and affiliate manufactured M98 ejector arm are shown at right.

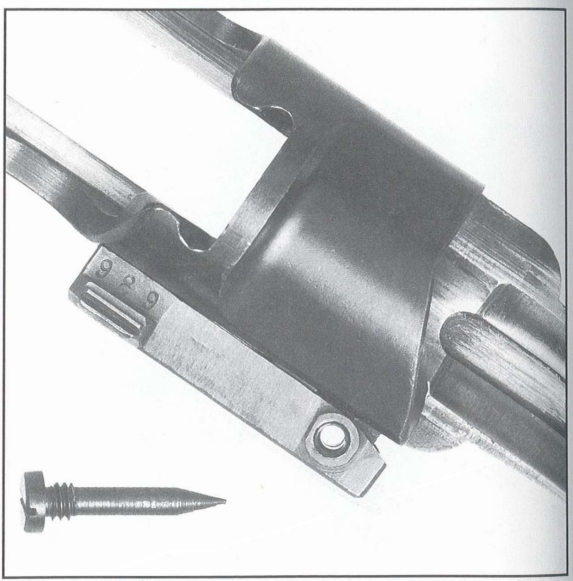


Figure 128- Shows an M94/M96 type ejector box assembly positioned on the receiver after cleaning and inspection. The ejector arm pivot hole is lined up with the pivot hole in the ejector box with a small drift before pushing in the pointed pivot screw. Pivot screw threads should be hand started to prevent thread damage. The pivot screw has only four threads. Don't over tighten.



Figure 129- Shows M98K carbine and M93 S. R. trigger guard/magazine assemblies, at left. Receiver mounting screws with and without set screw notches are shown at right. Most military contracts specified lock screws to prevent the receiver mounting screws from loosening or falling out. Set screws are located in front of the forward receiver mounting screw on long strap models such as the M98K.

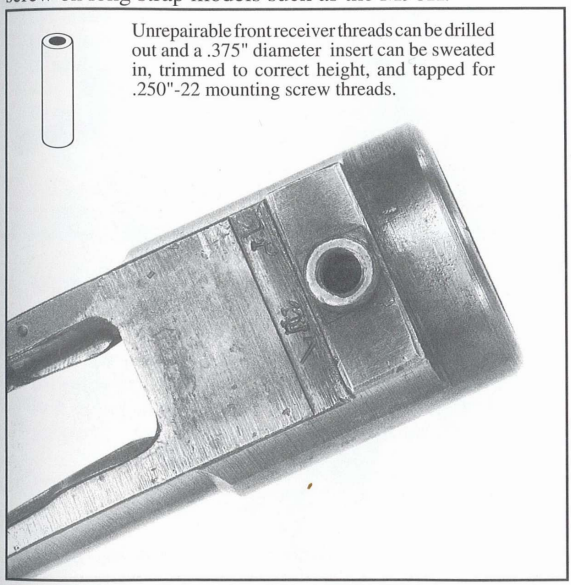


Figure 130- Shows an M98 receiver with nicked front mounting screw threads. Slightly damaged threads can be chased and cleaned with a .250"-22 tap. In an otherwise serviceable receiver, stripped threads can be drilled out and a mild steel insert sweated in with Force 44 solder. The insert is then drilled and tapped to original .250"-22 thread size.

About M91~M98 Trigger Guard Receiver Mounting Screws-

M91~M98 rear trigger guard receiver mounting screws measure in the 1.65"-1.80" OAL range. Head thickness accounts for most of the difference. The rear mounting screw must be long enough to fully engage the receiver threads. If the rear screw extends past the top of the receiver cocking piece slot, shorten it on the lathe to flush receiver fit.

M93~M98 front receiver mounting screws measure .960"-.980" OAL- again, head thickness accounts for most of the difference.

M91/M92 front mounting screws measure approx. .865-.870" OAL. Replacements for M91/M92 front screws are easily made by shortening M93~M98 front screws.

Replacement Screws

New replacement screws are available in three styles: standard with slotted head; standard with slotted head, recessed for military type set screws; and Allen head.

Military trigger guards with set screw recesses can be converted to commercial sporter appearance by TIG welding in a mild steel plug and then cleaning the mounting screw head recess with a piloted .400" diameter counterbore.

Damaged Receiver Threads

Fortunately, receiver thread damage is usually minor and limited to the first or second thread. Slightly damaged threads are easily cleaned by chasing with a .250"-22 tap.

A judgement call is in order in rare cases when receiver threads are severely damaged. If the receiver is serviceable, threads can be milled out with a 3/8" end mill. A .375" mild steel insert is made on the lathe and sweated in with low temp. Force 44 solder (flows at 475° F). The insert is then milled to original thread extension height. Then drill with a #7 drill (.201" dia.) and tap to the original .250"-22 thread size.

If the receiver is to be reheat treated, sweat the replacement thread insert in afterward. It would melt out and be lost in the reheat treating process.

Receiver Mounting in Stock

A correctly mounted Mauser receiver must rest solidly on steel: i.e on the trigger guard housing receiver mount, at front, and on the trigger guard/receiver spacer sleeve, at rear. Stock mounting that springs or tweaks the receiver, or that flexes or pulls down the rear of the receiver, will stress load the barrel, in turn. This condition is a major cause of stringing and general inaccuracy problems in bolt action rifles.

Receiver stress in Mauser actions can be eliminated by levelling the receiver and bedding in a correct length steel rear receiver spacer sleeve. In stocks with crossbolts, the crossbolt should be glass bedded first so that it will not allow receiver movement. See figures 131 & 132.

Sporter stocks should be glass bedded behind the receiver recoil lug, under the receiver ring, and about 3" forward for full support.

In actions stocked this way, receiver mounting screws should be torqued just tight enough to prevent the action from moving in the stock.

When action mounting is correct, stock, stock hardware, and barrel band pressures on the barrel can then be adjusted to improve overall accuracy. The barrelled action and stock can be final assembled when fit is correct. See Section II for additional data on glass bedding, barrel stress, and dampening.

Tighten Stock Crossbolt

The combination of recoil and a loose crossbolt is known to crack stocks. Tighten loose crossbolt nuts with the wrench shown in figure 132. Single and double nut crossbolts are commonly found. Loose crossbolts can be bedded and reinforced with Acraglas compound. Crossbolts, threads, and nuts must be well coated with release compound to prevent the possibility of being permanently attached to the stock. As a safety measure, the crossbolt should be removed, oiled, and reinstalled before the bedding compound has completely hardened.

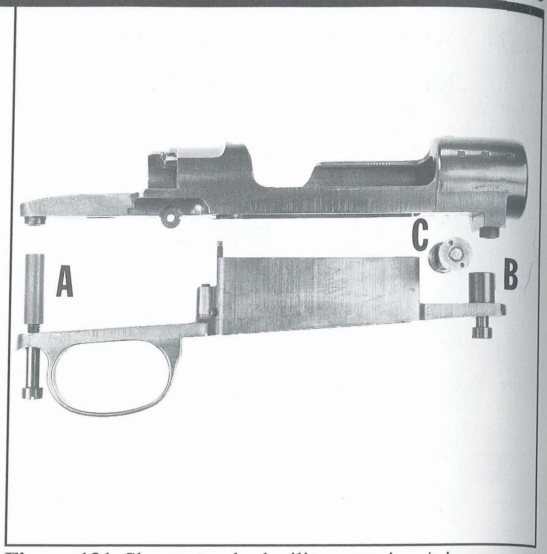


Figure 131- Shows standard military receiver/trigger guard mounting. The rear trigger guard/receiver spacer sleeve, at **A**, and the front receiver mount, at **B**, provide positive metal to metal contact and minimize receiver flexing. The stock crossbolt, at **C**, reinforces the stock behind the receiver lug and distributes recoil. Loose crossbolt nuts can be tightened with the wrench shown in figure 132.

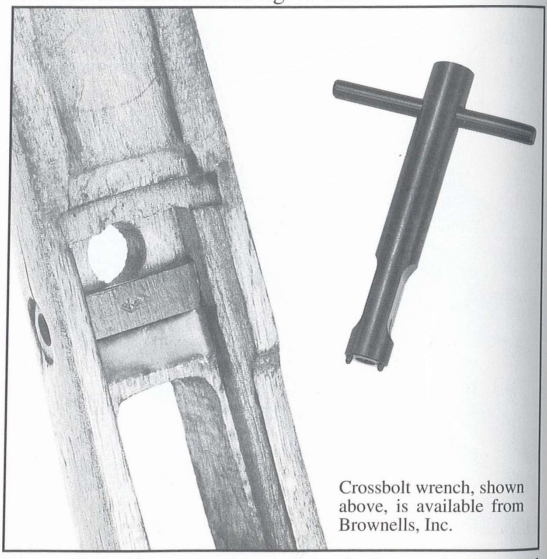


Figure 132- Shows the crossbolt backed up and reinforced with **Acraglas** in a military stock. The loose crossbolt could not be tightened due to wood compression. Glass bedding was a workable remedy because the stock was not oil impregnaged. The areas behind and below the crossbolt are relieved to increase for greater bedding material thickness.

M91~M98 Mauser Action After Assembly Function Checks-

Although all action parts have been individually inspected and function checked during reassembly, the bolt assembly, including the safety mechanism and extractor, trigger, magazine, and ejector must be function checked and the assembled action rechecked as a working system before loading or test firing, or using the rifle in the field.

Detail function check the action even if the rifle or action was disassembled only for cleaning and parts inspection. Keep in mind that the simple removal of accumulated dried oil and dirt residue will show parts clearances and spring tensions as they actually are. For example, a detailed cleaning of the bolt body could reveal that the firing pin port is actually oversize. Polishing nicked, burred, or rough edges of firing mechanism parts, when sear rest position and cocking piece ledge engagement is borderline, could lessen sear engagement and possibly cause trigger problems and slam fires or impact firing mechanism releases.

Function check as follows:

1. M98 bolts- must full cock on opening and cycle and close smoothly. Military type bolt sleeves must remain locked until the sleeve lock plunger has been depressed against the receiver.

2. M91~M96 bolts- must quarter cock on opening, cycle smoothly, and full cock on closing. No action resistance other than firing pin spring compression should be felt.

3. M91~M98 firing pin safety levers- must pick up the cocking piece and have a positive safety detent. The bolt must not open with the safety lever in the safe position.

4. M91~M98 military triggers- check by pulling the trigger with the firing pin safety lever in the safe position. The firing mechanism must not click, jump, or release.

5. M91~M98 military triggers- pull the trigger again with the safety on, as above. The trigger must cycle and return smoothly. The sear must clear the cocking piece engagement ledge with the firing pin safety lever in the safe position. When the trigger is released, the trigger and sear must return to normal rest position without sear/cocking piece contact.

6. Return the firing pin safety lever to the safety-off position after the trigger has been pulled. The firing mechanism must not release.

7. Adjustable triggers- consult trigger manufacturer's adjustment instructions and safety warnings. Make sure the trigger has been adjusted correctly. Check for smooth, crisp trigger and firing mechanism release. See trigger pull on page 97 and slam/impact fire warnings on pages 98 and 99.

8. Military type triggers- place the safety lever in the off position and check for smooth firing mechanism release. See trigger pull on page 97 and slam/impact fires on page 98.

9. Load the magazine with dummy cartridges. Check for smooth magazine cartridge loading and follower deflection. Also check for smooth bolt, magazine, extractor, and ejector function. The bolt and ejector claw should pick up cartridge rims when the bolt has travelled 1/2 to 2/3 of the way forward. Cartridges should ramp and chamber smoothly.

10. Final inspect the bore and chamber. Before firing, run solvent wet patches followed by dry patches through the chamber and bore to remove possible dirt, grit, or foreign material.

11. Install an unloaded, neck resized cartridge case with an oil dampened primer installed. Release the trigger and check for center of primer firing pin indentation.

12. Always check headspace before test firing, and as discussed earlier.

If any aspect of bolt, safety system, magazine, or other action function is found incorrect or questionable, identify the problem and fix it before attempting to test fire or use the rifle. See index for appropriate headings.

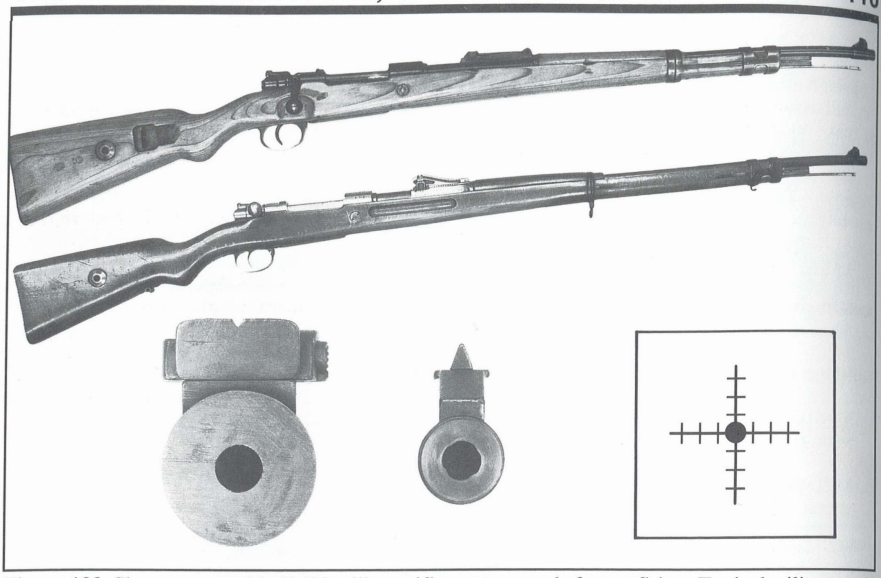


Figure 133- Shows reassembled M98 military rifles, at top, ready for test firing. Typical military style front and rear sights are shown, below. Before test firing, see "After Assembly Function Checks" on page 109 and cautions on pages 112~115. Test firing is best done from a sand bag and bench rest.

Before rifles with mechanical or open sights can be test fired for accuracy, front and rear sights must be tight; the sight elevator leaf must be straight; the elevator pivot pin must be tight; and both sights must be positioned on the barrel at 12:00. See sight work in Section II.

Standard military rear sights are adjustable for elevation only. The front sight is adjustable for windage by drifting the sight blade to the right or left in the sight ramp dovetail. Moving the front blade to the left changes point of impact to the right, etc. As a rough rule of thumb, a change in front blade position of .001" would move point of impact about 1" at 100 yards. The actual amount of change would be dependent upon sight radius and distance to the target.

When sights are new or have been moved to the extent that the approximate point of bullet impact vs. sight picture isn't known, basic sight agreement with the barrel can be prechecked by securing the rifle in a rifle vise, with the bolt removed, and visually centering the bore on the black circle on a bore sighting card, as illustrated above. The circle on the sighting card should be large enough so that, at 100 yards, it will seem to nearly fill the bore. If the black circle is centered in the bore, and the barrel is concentric and straight, the front sight blade should appear to be very close to, or on top of, the vertical windage line on the sighting card. If front sight windage position looks close, remove the rifle from the vise and test fire from a sand bag and bench rest. Bore sighting is also useful when preadjusting telescopic sights.

Unless the rear sight elevator leaf has been bent down or otherwise modified, minimum elevation setting on most Mauser military rifles is 200 or 300 meters. Minimum elevation on M98K type rear sights is 100 meters. With most military and sporting ammunition, a 300 meter zero would typically place point of impact between 5" and 8" high at 100 yards.

As rounds are test fired, check for smooth extraction of the fired cases, inspect brass cases and primers for pressure signs, and look for any indication of a chamber or firing pin related problem. As far as accuracy is concerned, don't expect too much from worn military barrels- average 100 yard groups, with factory ammunition, are seldom tighter than 5" to 6", at best. Military replacement barrels in new condition typically produce 2 1/2" to 4" groups at 100 yards. Well fit, good quality light sporter barrels usually produce 1" to 2" groups at the same yardage.

Summing up Section I . . .

In this first section, we have covered Mauser M91 through M98 parts identification and the majority of the shop inspection, general parts fitting, adjustment work, safety checks, and function checks that the professional riflesmith would likely perform at the bench. The nongunsmith might find this kind of detailed information somewhat tedious or even of limited interest. However, basic nuts-and-bolts information is necessary. The fact is that, as a professional riflesmith, you will see actions and rifles of all ages and in all levels of condition, including those that are in mechanically excellent condition brought in for headspace checking and cleaning to others in need of barrel replacement or major rebuilding. Occasionally, you will probably be asked to repair rifles that are well beyond reasonable or safe repair.

For safety and liability reasons- always operate from a *worst possible condition* scenario so that nothing is overlooked. Although you may not have included the cost of chamber casting and a detailed overall inspection, including headspace measurement, safety system operation, and trigger pull checks, etc., take the time and do it, just the same. It's cheap insurance. It may be that your **work order notes** and/or your **cautionary advice** to your customer might protect you both from harm.

No matter how simple the required work is, do it thoroughly- and **always recheck it**. While working, take the extra care to protect the finish on your customer's gun. Finish damage is evidence of poor craftsmanship. Common sense, a clean work bench, and careful handling can eliminate finish damage.

Now and then, the beginning riflesmith may find himself in doubt about some aspect of the job at hand. Should this happen, have the problem, or your work, checked by a senior gunsmith who is Mauser action qualified. Don't fog a problem over and send a rifle on its way as if whatever it was had been magically corrected. The capable individual knows when he has a problem- **but the wise riflesmith gets a second opinion, when needed**. An even wiser shop supervisor watches for those who can be depended upon to do things safely and well.

In this time of impossible product liability in the U.S. and, for many, nearly unobtainable insurance, the riflesmith has to be careful to the point of the ridiculous. There is just no such thing as too much caution. We all owe it to each other to preserve our industry. Shop safety training, technical training, work inspection, and quality control are good places to start. Thoughtful customer advice is also important. Dont forget that, as a professional riflesmith, you are the expert in your field. Don't hesitate to mention a problem area, particularly when customer safety is involved. **Where safety is concerned, prevention is always paramount**.

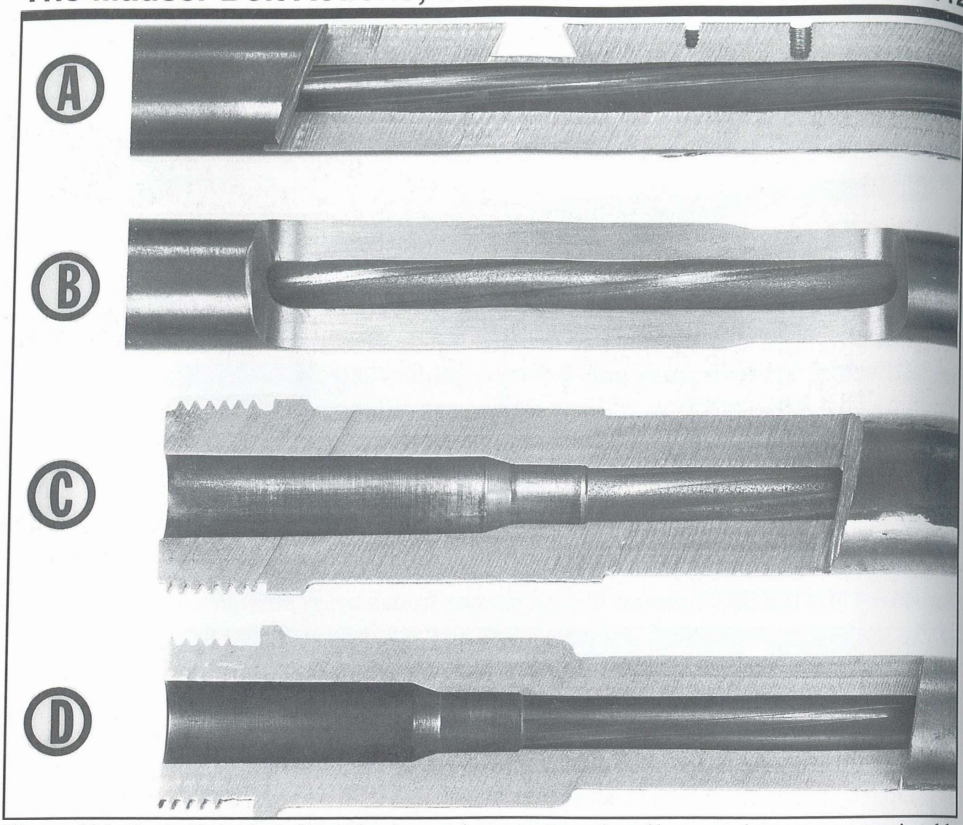


Figure 134- The half-sectioned barrels, shown above, were replaced because they were unserviceable or potentially dangerous, as discussed below:

The military barrel, at **A**, was intended for use in a jiffy, home made, sporter conversion. This barrel has almost eveything imagineable wrong with it including a dovetail cut almost into the bore and sight screw holes drilled nearly through the barrel. While installing a replacement sight, the owner of the rifle began to suspect that this might be a dangerous barrel. Fortunately, this prompted him to bring the rifle in for inspection. Had a round been fired through this barrel, it would have ruptured.

The M98 bore, at **B**, is heavily rust pitted from corrosive primer salts residue. Scrubbing out the rust with stainless steel brushes removes oxide from the bore but oversizes the bore in the process. Although most barrels in this condition are probably safe to fire, they are extremely inaccurate.

The M98 barrel, at **C**, apparently had moderate chamber and bore pitting. Rust had been scrubbed out of the chamber, leaving it oversized. An exporter had requalified the barrel in this potentially dangerous condition. Re-reaming the chamber to headspace the rifle could not clean up the chamber. The chamber throat is also oversize. Cartridge cases fired in this chamber overexpanded and usually head separated on the second firing after resizing. Needless to say, this barrel is also inaccurate.

In the Spanish made M1916 barrel, at **D,** the chamber is misreamed and irregular. The bore is also bulged several inches ahead of the chamber. This barrel would have required replacement for either reason. Bulges located near the chamber, as shown above, can accellerate and then slow bullets, cause bullet deformation, and create unusual, even dangerous, compound pressure curves, similar to the pressure curves generated by squib loads in magnum rifles. Whether barrels bulged near the chamber rupture for this reason or because the metal in the bulged area has been weakened is unknown.

When a bore is allowed to rust, an oxide layer builds up over a period of time. This buildup undersizes the diameter of the bore. If a round was fired through a bore in this condition, the barrel would probably rupture. Figure 135 provides a graphic example. Bulged barrels and barrels with rusted or otherwise damaged bores and/or with misreamed, oversized, or otherwise damaged chambers are inaccurate and either unsafe, or potentially unsafe, and must not be used. See barrel replacement in Section II.

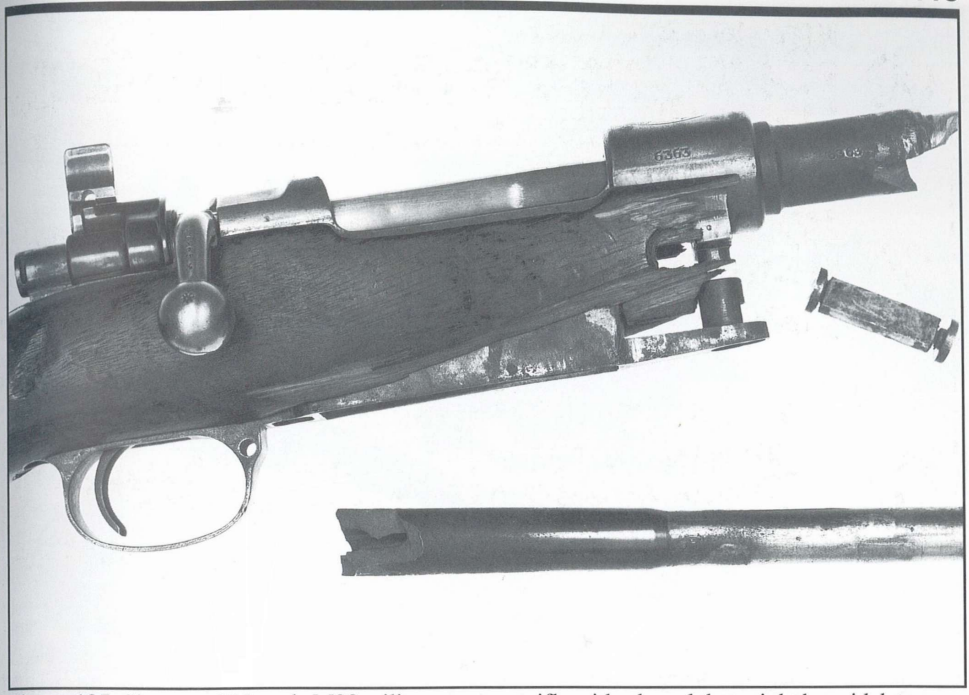


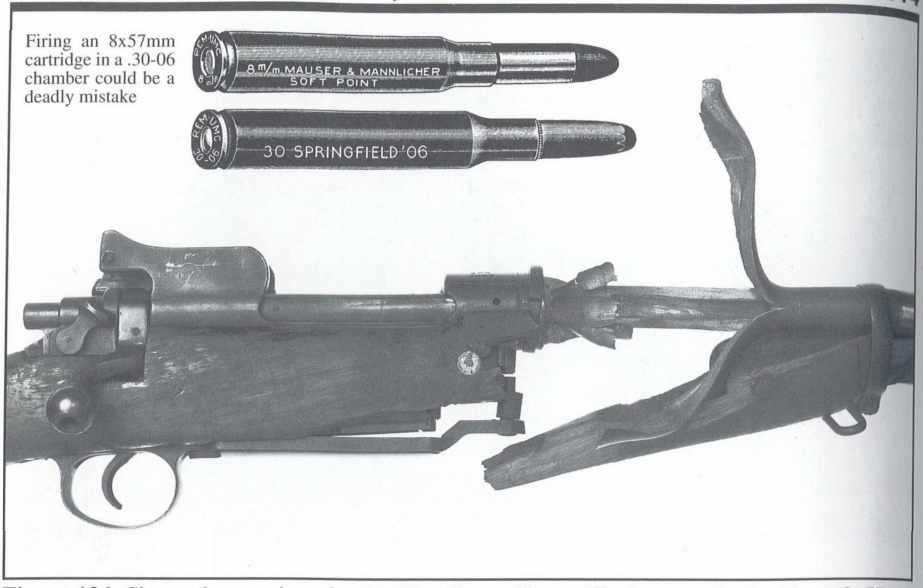
Figure 135- Shows an FN made M98 military contract rifle with a barrel that might be said, by some, to have blown up. It has been known for some time that every effect has a cause, and that no rifle or barrel, to date, has ever blown up by itself- ***and this case was no different***. What happened here was that the barrel was ruptured when the owner attempted to fire a single commercial factory round through a rust undersized bore. Examination of the two remaining barrel sections confirmed that the cause of the rupture was an oxide (rust) build-up which had undersized and roughened the bore.

The midsection of the stock and several inches of the barrel, beginning at the chamber throat, literally fragmented. Very few pieces, including the magazine floorplate, spring, and follower, were found. Although the bolt had to be driven open with a rawhide mallet, the receiver was not damaged beyond light setback in the lug area. Close inspection and magnafluxing confirmed that the receiver had not cracked or sustained other damage. Barrel hardness tests indicated that the barrel was not harder than others of the same type. Headspace was checked for reference after the remainder of the cartridge case was driven out and the chamber had been detail cleaned. The bolt was apparently undamaged and would just close with light resistance on a no-go gauge. This would indicate that headspace was undoubtedly in the serviceable range before this mishap. It is interesting to note that, although the primer had blown and the cartridge had expanded, the cartridge head was still in one piece. Another point of interest is that when the rust buildup was scrubbed out of a portion of the bore and the bore was then cast with Cerrosafe and measured, the scrubbed out portion was oversize, as expected.

Had the owner taken this rifle to a professional riflesmith or gunsmith for inspection, he would have been told, in no uncertain terms, that the bore was rusted and that the rifle was not safe to fire.

If this individual had inspected the bore himself, he couldn't have failed to see the rust buildup. According to his comments, however, he didn't see the need to inspect the bore.

Fortunately, the owner of this rifle wasn't injured beyond having to have wood splinters and small metal fragments removed from his hide. In spite of the obviousness of his folly to those familiar with the subject, this fellow remained convinced that he was in no way responsible for his misfortune and that the gun just blew up.



Firing an 8x57mm cartridge in a .30-06 chamber could be a deadly mistake

Figure 136- Shows the remains of a .30-06 caliber military rifle that was fired with an 8x57mm cartridge in the chamber. See "Unsafe Arms and Ammunition Combinations" on pages 82~85.

Even at normal operating pressures, a sudden propellant gas release or venting of gasses into a rifle action through a ruptured or blown primer or a cracked, ruptured, or blown cartridge case, could be injurious or deadly, depending on conditions and the particular rifle action. However, a blow-up caused by an oversize bullet (as above); a bore obstruction; a bore irregularity, and/or any other barrel/ ammunition size related condition that would cause an extreme pressure curve, could be much worse- because pressures could be generated that are well in excess of basic barrel material strength.

When smokeless powder is combusted within a cartridge case, propellant gas pressure is generated on a temperature/pressure curve. The effects are additive: the higher the gas pressure, the hotter the gas temperature, the faster the burning rate, the higher the gas pressure, and so on, until all of the powder that will burn has been burned.

In the example above and on page 113, the barrels ruptured in the chamber and chamber throat areas rather than further down the barrel. This tells us that the pressure curves in both barrels were unusually steep, and that gas pressures were forced to multiply excessively. It also graphically confirms that any condition or force that slows or restricts bullet travel at any point in the barrel will dangerously affect a normal pressure curve.

Unusual and severe compound pressure curves sometimes occur when underloaded cartridges (squib loads) are fired in perfectly serviceable rifles. There are several variables that can affect the outcome of firing such loads, including where the powder happens to be situated in the case at the time of firing. What happens inside the cartridge, in worst cases, is that the primer fires over much of the powder rather than into the bulk of the charge. This tends to cause a relatively low initial burning rate and serves to burn off some of the combustion control coating on the powder granules. The low level combustion/ gas generation rate that follows sometimes just starts the bullet down the bore. The resulting gas expansion and pressure drop further lowers the powder combustion rate and burning temperature which further lowers gas pressure. At this point, depending on powder mixing and turbulence inside the cartridge case (and in the bore behind the bullet), there will be either enough heat to allow combustion to continue or combustion will stop. In the worst of cases, powder mixing, turbulence, reduced powder combustion control coating effectiveness, and remaining heat can interact to drastically multiply the combustion rate. This, in turn, will cause the temperature/pressure curve to reestablish behind a, by then, slowed bullet which acts as an obstruction. The net effect is that the pressure curve spikes and goes through the roof. Using a slow burning powder in a squib load can add to the problem. Squib loads are a major cause of mysterious blow-ups in rifles in serviceable condition.

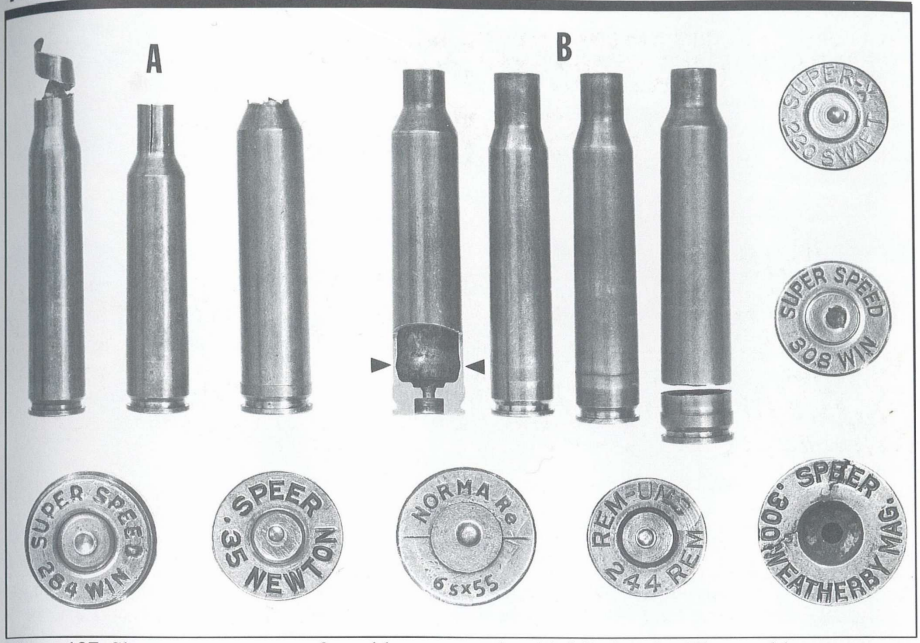


Figure 137- Shows an assortment of cartridge cases, at **A**, with failed necks. The cartridge case group, at **B**, shows examples of incipient and complete case head separation. The cutaway case, see arrows, shows thinning of brass case walls that leads to head separation. The cartridge case heads at right and bottom show signs of excessive pressure and/or firing pin related problems. Causes of the above problems are discussed below:

1. The three cartridge case necks, in group **A**, cracked or broke as a result of work hardening (case neck firing expansion and repeated resizing).

2. Incipient case head separations and the complete head separation in the four cartridge case group, at **B,** were also work hardened from repeated firing expansion and full length resizing. Oversize chambers and excessive headspace permit increased case expansion and accelerate work hardening. The walls of cartridge cases in this condition require excessive compression and movement of metal to return them to shape in the resizing process. New cartridge cases fire formed to chambers in single shot rifles and neck resized only, thereafter, last almost indefinitely if necks are periodically annealed. Incipient head separation is usually detectable by the presence of a thin stretch ring or line around the case just ahead of the solid base section. Location varies somewhat with the specific round, brand, and production lot. Check all cartridge cases regularly.

3. The cracked .300 magnum cartridge case head and blown primer were caused by excessive pressure.

4. The flattened case head and flattened primer in the 6.5x55 case were also caused by excessive pressure. Flattening can also be caused by a combination of excessive pressure and headspace. (Cartridge heads are slap peened against the bolt face.)

5. The scarred .244 Remington case and cratered primer were also caused by excessive pressure. The dark smoke ring around the primer indicates leakage. Although primer leakage can result from high pressure, it is usually caused by a misreamed primer pocket.

6. The extruded primer in the .284 Winchester case was caused by an oversize firing pin port.

7. The primer in the .35 Newton case had backed out and begun to extrude into the firing pin port. This was caused by excessive headspace and an undersized firing pin tip.

8. The flattened/impressed primer in the .220 Swift case is an indication of high pressure. The primer was cracked by high pressure and a sharp firing pin tip.

9. The primer in the .308 Win. case was punctured by a too long firing pin. (Excessive protrusion)

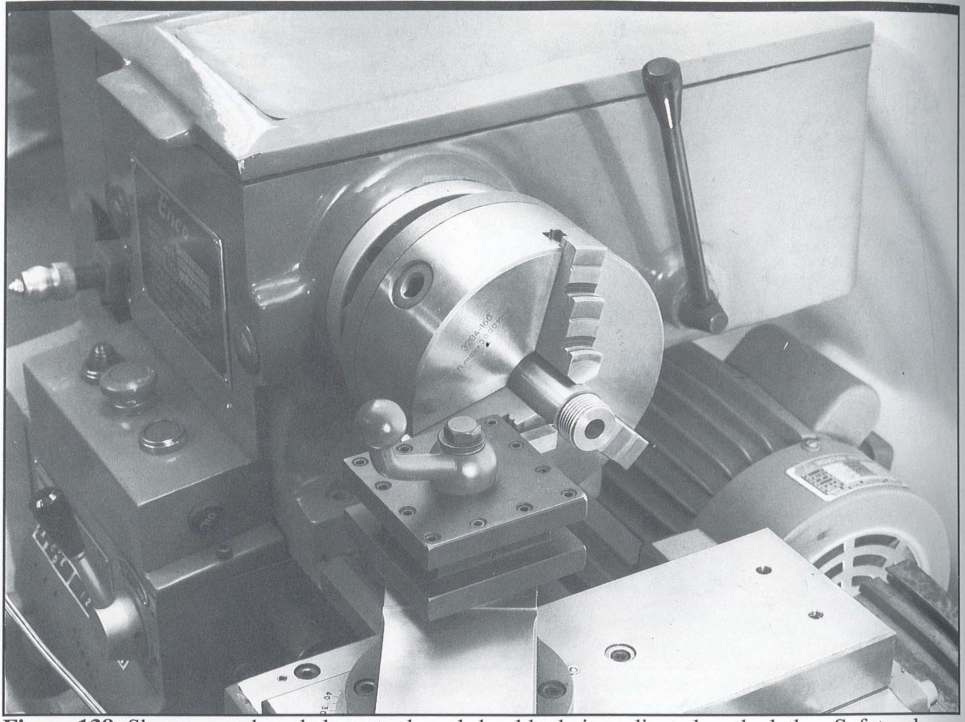


Figure 138- Shows a prethreaded sporter barrel shoulder being adjusted on the lathe. Safety glasses or safety goggles should always be worn when working at the lathe or with any power tool or power equipment. Unless we routinely wear glasses, we have the tendency to concentrate on machine set-up details and forget about safety glasses. Although stray cutting chips are an infrequent problem in lathe gunsmithing work, it takes only one small chip or a broken tool fragment to seriously damage an eye. I've always been glad that I had glasses on when an invisible, high speed fragment, from who knows where, "tinks" off a lens instead of landing in my eye.

Another problem we sometimes joke about is the lathe chuck key left in the chuck and then thrown when the operator starts the lathe. A standard preventitive is to safety chain the lathe key to a structural member above the lathe and extend the last two feet on a spring. In this way, when the operator releases the chuck key, it immediately returns to a position a foot or so above the lathe.

Bench and floor mounted grinders must not be operated without wheel guards and vision shields. Surface grinders should have particle catchers to stop the high speed carborundum and metal particles that exit the work horizontally. Limit wheel breakage potential with all grinders by keeping grinding wheels dressed and true, and by making sure the paper end discs or labels are intact on each wheel.

Make it a point to read chemical and solvent manufacturers' general instructions, user safety warnings, and ventilation requirements before opening containers and/or using the contents. Many gunsmithing chemicals, cleaning solvents, and metal finishing chemical treatments, etc., can't be legally disposed of by pouring them down the drain or by placing the containers in the trash pickup bin. In many areas, industrial chemicals, including hot bluing salts, require some amount of special handling and/or neutralizing before disposal. Avoid potential problems by consulting product manufacturers and local agencies on this subject.

Many of these chemicals are dangerous. Hot caustics, for example, can burn through shoe leather in short order. Both acids and caustics are injurious to eyes and skin. Always keep rinse water and neutralizing solutions at hand in the work area. And always use correct safety gear, such as safety goggles, face shields, rubber gloves, rubber aprons, rubber boots, etc., particularly when handling or using acids or caustics. Quality protective gear and gunsmithing supplies are available from **Brownell's Inc.**, Route 2, Box 1, Montezuma Iowa 50171. If you don't have a copy of Brownells excellent catalog, write for one.

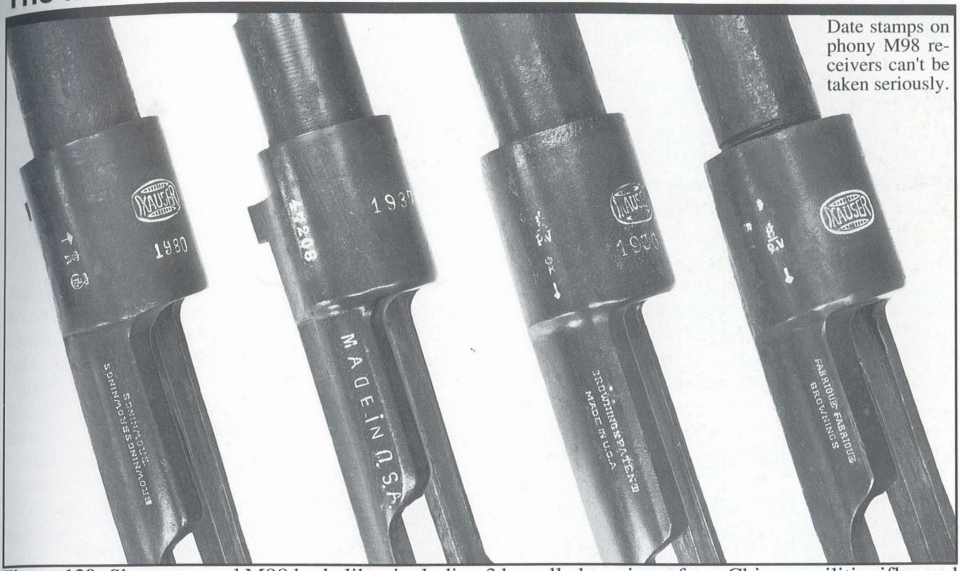


Figure 139- Shows several M98 lookalikes including 3 barrelled receivers from Chinese militia rifles and another that was made in the Middle East. These rifles are sometimes called "phony Mausers"because of the counterfeit Mauser banner imprints, FN and/or Browning imprints, etc., and bogus Belgian or other European proof marks. Note that some characters, or entire lines, are stamped upside down. The "made in U.S.A." stamping has to be a case of a manufacturer kidding the locals. Some receivers and barrels are fully machined- but most are hand forged (blacksmithed), scraped and filed on the outside, and roughly machined on the inside. Of those examined, no two were the same. Barrel threads varied considerably.

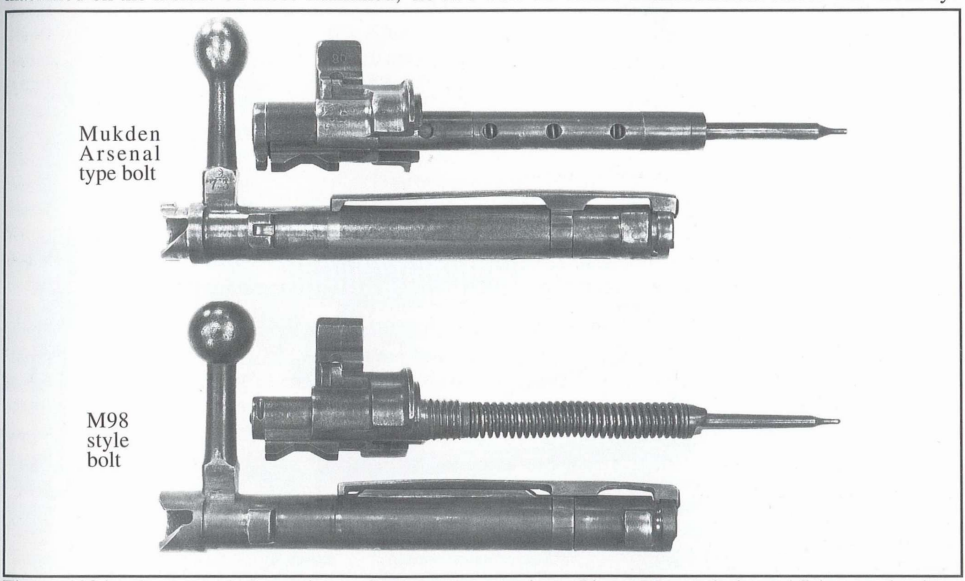
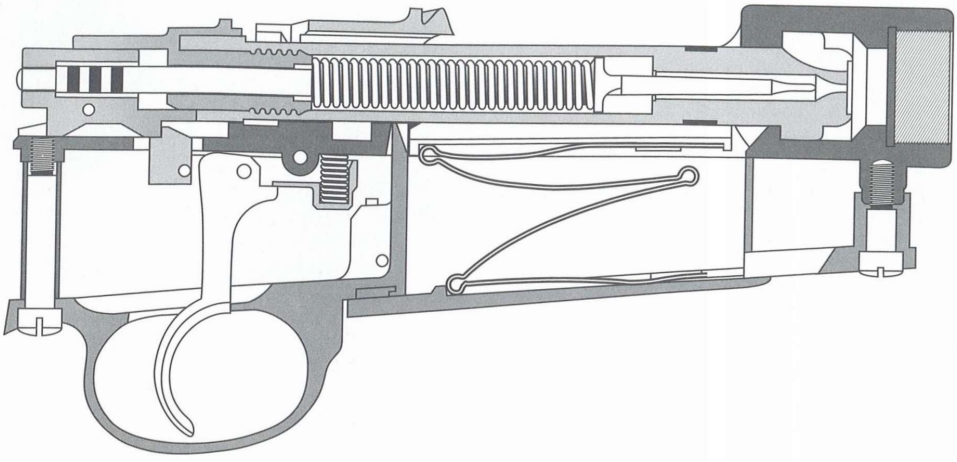
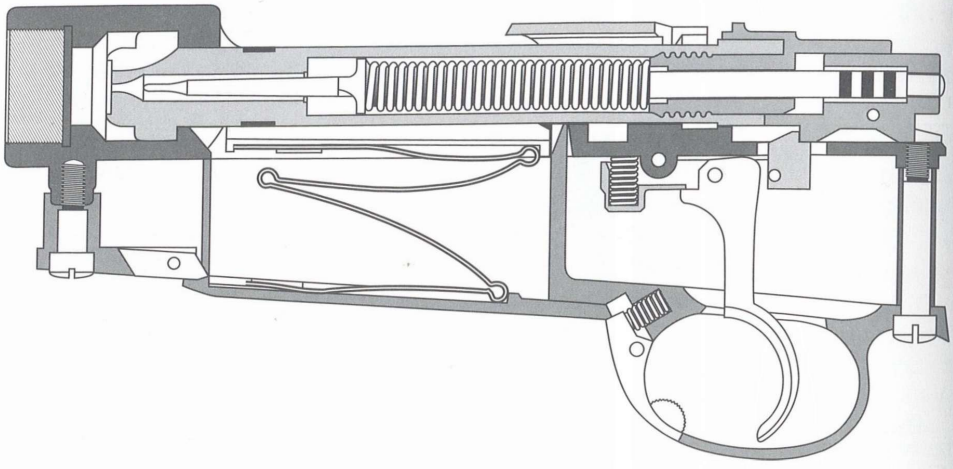


Figure 139A- Shows two bolt specimens from the above actions. Phony Mauser bolts and firing mechanisms seem to divide into the two categories shown: i.e., those that resemble a real M98 bolt asssembly and others that are possible copies of, or leftovers from, WWII Mukden Arsenal production. See Ludwig Olson's book Mauser Bolt Rifles on this subject. **Warning**: Steels, steel quality, and heat treats used in the specimens I have examined have ranged from questionable to very poor. Do not attempt to use parts from these rifles or to fire them. If in doubt as to the genuineness of any Mauser rifle, action, or part, have it inspected by a qualified expert. Although bolt and receiver lugs seldom agree enough to engage correctly, some lookalike M98 receivers are dimensionally close enough on the inside to permit installation of a genuine M98 bolt. In this connection, I have seen a number of counterfeit M98 actions with European made bolt assemblies in them. Whether this was part of original rifle manufacture or downstream replacement is unknown.

TROUBLESHOOTING GUIDE





Military and commercial M98 actions are shown for reference. Illustrations are not to scale.

WHERE?	WHAT IS IT?	CHECK FOR:	REMARK:
Barrel	Copper fouling	Normal amount?	Use copper solvent/oil patch
Barrel	Heavy fouling	Rough lands/grooves?	Lap or replace barrel
Barrel	Heavy fouling	Velocity/twist problem?	Check twist, bullet, and load
Barrel	Heavy fouling	Velocity/twist O.K.?	Check bullet diameter
Barrel	Heavy fouling	Bullet diameter O.K.?	Check bore diameter
Barrel	Heavy fouling	Bore/bullet dia. O.K?	Check bullet gilding metal
Barrel	Heavy fouling	Gilding metal O.K.?	Use copper solvent/oil patch
Barrel	Leading (lead bullets)	Velocity too high?	Check load, adjust velocity
Barrel	Leading (lead bullets)	Velocity O.K.?	Check lead bullet alloy
Barrel	Leading (lead bullets)	Lead alloy too soft?	Adjust alloy
Barrel	Leading (lead bullets)	Lead alloy O.K.?	Adjust bullet lubricant
Barrel	Rusty	Light rust in bore?	Scrub out or replace barrel
Barrel	Rusted	Light rust outside?	Refinish or replace barrel
Barrel	Pitted	Medium or worse pits?	Replace barrel
Barrel	Visibly bent or damaged	Receiver O.K?	Replace barrel
Barrel	Crown damaged	Bore otherwise O.K.?	Recut crown and lap
Barrel	Crown expanded	No further checks	Replace barrel
Barrel	Bulged/swelled	No further checks	Replace barrel
Barrel	Cracked	No further checks	Replace barrel
Barrel	Bore irregular	No further checks	Replace barrel
Barrel	Bore scarred or damaged	No further checks	Replace barrel
Barrel	Nonconcentric	No further checks	Replace barrel
Barrel	Deformed exterior	Not straight?	Replace barrel
Barrel	Deformed exterior	Out of round?	Turn or replace barrel
Barrel	Deformed exterior	O.D. turned too thin?	Replace barrel
Barrel	Deformed exterior	Sight thds/dovetail too deep?	Replace barrel
Barrel	Sleeve or liner installed	No further checks	Replace barrel
Barrel	Bullet stuck	Chamber/bore O.K.?	Replace barrel if bulged or swelled
Barrel	Hard case extraction	Chamber scored or pitted?	Requalify or replace barrel
Barrel	Hard case extraction	Chamber dirty?	Detail clean chamber and bore
Barrel	Hard case extraction	Chamber clean?	Check for open headspace
Barrel	Hard case extraction	Headspace O.K.?	Check for signs of high pressure
Barrel	Hard case extraction	High pressure load?	Consult loading manual and adjust
Barrel	Loose in receiver	Insufficient torque?	Retorque/adjust headspace
Barrel	Loose in receiver	Shoulder(s) misfit?	Requalify barrel
Barrel	Loose in receiver	Barrel thread problem?	Replace barrel
Barrel	Loose in receiver	Receiver thread problem?	Replace receiver
Barrel	Loose in receiver	Receiver cracked?	Replace receiver
Barrel	Not straight in receiver	Barrel thread problem?	Replace barrel
Barrel	Not straight in receiver	Receiver thread problem?	Replace receiver
Barrel	Bolt binds ctg. in chamber	Wrong bolt?	Check headspace/verify bolt is correct
Barrel	Bolt binds ctg. in chamber	Case resizing problem?	Check/adjust loading dies
Barrel	Bolt binds ctg. in chamber	Bolt and dies O.K.?	Clean/Cerrosafe cast chamber
Barrel	Bolt binds ctg. in chamber	Casting looks normal?	Headspace check with go gauge
Barrel	Bolt binds ctg. in chamber	Chamber short?	Ream/check with go/no-go gauges
Barrel	Bolt closes on no-go gauge	Wrong bolt?	Make sure the bolt wasn't switched
Barrel	Bolt closes on no-go gauge	Chamber problem?	Clean/cast chamber with Cerrosafe
Barrel	Bolt closes on no-go gauge	Chamber undamaged?	Requalify or replace barrel
Barrel	Bolt closes on no-go gauge	Chamber unserviceable?	Replace barrel
Barrel	Cartridge case problems	Heads crack, separate?	Cast chamber/check headspace
Barrel	Cartridge case problems	Cases over expanded?	Cast chamber/check headspace
Barrel	Cartridge case problems	Case necks split?	Check for work hardened brass
Barrel	Cartridge case problems	Case necks split?	Cast chamber/check for oversize neck
Barrel	Chamber throat eroded	Light flame erosion?	Requalify or replace barrel
Barrel	Chamber throat eroded	More than light erosion?	Replace barrel
Barrel	Chamber/throat miscut	Throat sightly long?	If inaccurate, requalify barrel/chamber
Barrel	Chamber/throat miscut	Throat too long?	Replace barrel
Barrel	Chamber/throat miscut	Chamber/throat crooked?	Replace barrel

WHERE?	WHAT IS IT?	CHECK FOR:	REMARK:
Barrel	Chamber/throat miscut	Chamber/throat oversize?	Replace barrel
Barrel	Chamber lightly pitted	Barrel otherwise O.K.?	Requalify/replace barrel
Barrel	Chamber scratched	Barrel otherwise O.K.?	Requalify/replace barrel
Barrel	Chamber problem	Can't requalify/recut?	Replace barrel
Barrel	Shoulder crooked	Enough thd. to requallify?	True shoulder, requalify barrel
Barrel	Inaccurate	Crown damaged?	Recut crown and lap
Barrel	Inaccurate	Bore irregular?	Cast/measure bore/replace barrel
Barrel	Inaccurate	Bore oversize?	Cast/measure bore/replace barrel
Barrel	Inaccurate	Chamber problem?	Cast/measure/requalify/replace barrel
Barrel	Inaccurate	Throat problem?	Cast and measure with chamber
Barrel	Inaccurate	Headspace open?	Gauge check headspace
Barrel	Inaccurate	Twist rate correct?	Check twist rate vs. bullet velocity
Barrel	Inaccurate	Barrel internal stress?	Stress relieve or replace barrel
Barrel	Inaccurate	Barrel external stress?	Check/bed receiver, adjust forestock
Barrel	Inaccurate	Barrel external stress?	Dampen barrel at forestock
Barrel	Inaccurate	Vibration problem?	Check/adjust forestock pressure
Barrel	Inaccurate	Stringing problem?	Bed receiver/adjust stock pressure
Barrel	Inaccurate	Uneven lug engagement?	Check bolt lugs with Dykem Blue
Barrel	Inaccurate	Receiver mounting O.K.?	Rear spacer sleeve in place
Barrel	Inaccurate	Receiver moves?	Tighten/bed crossbolt
Barrel	Inaccurate	Receiver flexes?	Install spacer/bed receiver
Barrel	Inaccurate	Receiver stressed?	Install spacer/bed receiver
Barrel	Inaccurate	Large groups on target?	Check above possibilities
Barrel	Inaccurate	Large groups on target?	Check loading manual data
Barrel	Inaccurate	Large groups on target?	Check bore diameter/replace barrel
Bolt body	Drags in receiver	Extractor loose or bent?	Tighten fit/replace extractor
Bolt body	Drags in receiver	Ejector arm bent?	Straighten/replace ejector
Bolt body	Drags in receiver	Bolt body rough?	Check/polish bolt body
Bolt body	Drags in receiver	Bolt guide/lugways rough?	Check/polish guideways/lugways
Bolt body	Drags in receiver	Bolt guide/lugways O.K.?	Check receiver for tweak or bend
Bolt body	Drags in receiver	Receiver tweaked?	Straighten/replace receiver
Bolt body	Drags in receiver	Receiver not concentric?	Straighten/replace receiver
Bolt body	Assembly thread clearance	Bolt sleeve threads loose?	Check/replace bolt sleeve
Bolt body	Won't safety lock	Safety notch oversize?	Check/replace bolt body
Bolt body	M91~96 won't 1/4 cock	Cocking piece damaged?	Check/replace cocking piece
Bolt body	M91~96 won't 1/4 cock	Cocking piece O.K.?	Check/replace bolt body
Bolt body	M98 cocks rough	Cocking piece ramp galled?	Check/replace cocking piece
Bolt body	M98 cocks rough	Cocking piece damaged?	Check/replace cocking piece
Bolt body	M98 cocks rough	Bolt cocking cam soft/galled?	Check/replace bolt body
Bolt body	Primers extrude	Firing pin tip undersize?	Check/replace firing pin
Bolt body	Primers extrude	Firing pin tip O.K.?	Check/replace bolt body
Bolt body	Lug engage. problem	Lug contact even?	Check with Dykem Blue
Bolt body	Lug engage. problem	Lug contact uneven?	Lap/resurface receiver/bolt lugs
Bolt body	Lug engage. problem	Bolt altered/damaged?	Check/replace bolt
Bolt body	Lug engage. problem	Receiver lugs set back?	If less than .002" lap lugs/requal. barrel
Bolt body	Lug engage. problem	Lug setback over .003"?	Resurface receiver lugs/reheat treat
Bolt body	M98 bolt sleeve unlocks	Plunger and spring O.K. ?	Check/replace bolt body
Bolt body	M98 F.P. doesn't stop	Firing pin too long?	Check/replace firing pin
Bolt body	M98 F.P. doesn't stop	Fir. pin stop shoulders short?	Check/replace firing pin
Bolt body	M98 F.P. doesn't stop	Firing pin is O.K.?	Check/replace bolt body
Firing pin	Excess clearance in C.P.	Key slots stretched?	Replace firing pin
Firing pin	Excess clearance in C.P.	Cracks in key slots?	Replace firing pin
Firing pin	(M91)thds. loose in C.P.	Firing pin thds. undersize?	Replace firing pin
Firing pin	Hits primer off center	Firing pin tip bent?	Straighten/replace firing pin
Firing pin	Hits primer off center	Firing pin O.K.?	Check/replace bolt
Firing pin	Pierces primers	Excessive protrusion?	Check/adjust firing pin tip
Firing pin	Pierces primers	Tip altered or damaged?	Check/replace firing pin

WHERE?	WHAT IS IT?	CHECK FOR:	REMARK:
Firing pin	Misfires	Protrusion short?	Check/replace firing pin
Firing pin	(M98) won't safety stop	Safety shoulders short?	Chcek/replace firing pin
F.P. spring	(M91~96) bolt closes hard	Fir. pin spring binds in bolt?	Check/replace firing pin spring
F.P. spring	(M91~96) bolt closes hard	Spring over 19-22 lbs.	Check/replace firing pin spring
F.P. spring	Weak	Cartridges misfire?	(M91~96)- try 19-22 lb. firing pin spring
F.P. spring	Weak	Cartridges misfire?	(M98)- try 19-30 lb. firing pin spring
F.P. spring	Weak	Ignition variable?	Check F.P. spring and protrusion
F.P. spring	Cartridges misfire	Weak/short F.P. spring?	Check/replace firing pin spring
F.P. spring	Lock timing slow	Weak/short F.P. spring?	Install replacement firing pin spring
F.P. spring	Altered	Ground, short, thin?	Replace firing pin spring
F.P. spring	Substituted, wrong	No further checks	Replace firing pin spring
Cock. piece	Hits receiver screw	Receiver mtg. screw long?	Check/adjust screw length
Cock. piece	(M98) Hits receiver	Sleeve lock problem?	Check/replace sleeve lock plunger
Cock. piece	(M98) Hits receiver	Lock plunger O.K.?	Check bolt notch/replace bolt
Cock. piece	Safety-off fires	Engagement corner altered?	Replace cocking piece and recheck
Cock. piece	Safety-off fires	C.P. engagement ledge long?	Recheck with replacement C.P.
Cock. piece	Safety-off fires	Wrong sear dimension?	Recheck with replacement sear
Cock. piece	(M91) Safety-off fires	Bolt/C.P. thread problem?	Try replacement cocking piece/F.P.
Cock. piece	Safety-off fires	Still a problem?	Shorten C.P. eng. ledge & reharden
Bolt sleeve	Won't retain safety lever	Sleeve safety stud altered?	Check/replace bolt sleeve
Bolt sleeve	Won't retain safety lever	Bolt sleeve safety stud O.K?	Check/replace safety lever
Bolt sleeve	Won't retain safety lever	M91 safety detent damaged?	Check/replace M91 bolt sleeve
Bolt sleeve	Won't retain safety lever	M91 safety detent O.K?	Check/replace safety plunger and spring
Bolt sleeve	Assy. threads loose	Cocking piece moves?	Check sleeve/bolt body assy. threads
Bolt sleeve	Assy. threads loose	Bolt sleeve problem?	Check/replace bolt sleeve
Bolt sleeve	Assy. threads loose	Sleeve threads O.K.?	Check/replace bolt body
Mil. safety	Lever or pivot drags	Lever or pivot bent?	Straighten or replace safety lever
Mil. safety	Lever comes off sleeve	Lever or pivot bent?	Straighten or replace safety lever
Mil. safety	Lever comes off sleeve	Bolt sleeve damaged.?	Check/ replace bolt sleeve
Mil. safety	Pivot won't lock bolt	Pivot end alt./worn?	Check/replace safety lever
Mil. safety	Pivot won't lock bolt	Pivot end O.K.?	Check safety notch/replace bolt body
Mil. safety	Lever engagement stiff	C.P. eng. corner rough?	Lightly polish corner- don't undersize
Mil. safety	Lever engagement stiff	C.P. eng. corner O.K.?	Polish safety lever engagement cam
Mil. safety	Lever won't engage	C.P. eng. corner O.K.?	Adjust safety lever engagement cam
Sleeve lock	(M98) doesn't hold	Plunger or spring problem?	Check/replace plunger or spring
Sleeve lock	(M98) doesn't hold	Plunger altered or worn?	Check/replace lock plunger
Sleeve lock	(M98) doesn't hold	Plunger & spring O.K.?	Check/replace bolt body
Bolt assy.	M98 bolt sleeve unlocks	Plunger/spring problem?	Check/replace plunger/spring
Bolt assy.	M98 bolt sleeve unlocks	Plunger/spring O.K.?	Check/replace bolt body
Bolt assy.	Bolt sleeve threads loose	Permits C.P. movement?	Check/replace bolt sleeve
Bolt assy.	Bolt sleeve threads loose	Sleeve threads O.K.?	Check/replace bolt body
Bolt assy.	Firing pin misfires	F.P. short or damaged?	Check/replace firing pin
Bolt assy.	Firing pin misfires	Firing pin bent?	Check, straighten, or replace F.P.
Bolt assy.	Primer ignition erratic	F.P. short or damaged?	Check/replace firing pin
Bolt assy.	F.P. punctures primers	F.P. protrusion long?	Check/adjust protrusion
Bolt assy.	F.P. punctures primers	F.P. tip damaged?	Check/replace firing pin
Bolt assy.	C.P. loose on firing pin	Firing pin overtravels?	Check/replace cocking piece
Bolt assy.	C.P. loose on firing pin	Cocking piece O.K.?	Check/replace firing pin
Bolt assy.	M98 firing pin problem	Protrudes in safe position?	Check/replace wrong firing pin
Bolt assy.	M98 firing pin problem	Firing pin O.K.?	Check F.P. stop in bolt/replace bolt body
Bolt assy.	F.P. safety lever stiff	Lever or pivot bent?	Check/replace F.P. safety lever
Bolt assy.	F.P. safety lever stiff	Cocking piece corner rough?	Check/polish C.P. corner
Bolt assy.	F.P. safety lever stiff	Cocking piece O.K.?	Check/adjust lever cam
Bolt assy.	F.P. safety lever stuck	Cocking piece O.K.?	Check/adjust lever cam.
Bolt assy.	F.P. safety malfunctions	Fires when turned off?	Check altered C.P. engagement corner
Bolt assy.	F.P. safety malfunctions	C.P. corner altered?	Replace cocking piece/recheck

WHERE?	WHAT IS IT?	CHECK FOR:	REMARK:
Bolt assy.	F.P. safety malfunctions	Still safety-off fires?	Clearance C.P. eng. ledge and reharden
Bolt assy.	F.P. safety malfunctions	Safety detent altered?	Check/replace F.P. safety lever
Bolt assy.	F.P. safety loose	Safety lever bent?	Adjust/replace firing pin safety lever
Bolt assy.	C.P. ramp drags bolt cam	C.P. cocking ramp galled?	Check/replace soft cocking piece
Bolt assy.	C.P. ramp drags bolt cam	Bolt cocking cam galled?	Check/replace bolt body
Bolt assy.	C.P. slips off M98 bolt	Sleeve lock problem?	Check/replace sleeve lock plunger
Bolt assy.	C.P. slips off M98 bolt	Lock plunger O.K.?	Check/replace bolt body
Bolt assy.	C.P. slips off M98 bolt	C.P. engagement problem?	Check/replace cocking piece
Bolt assy.	C.P. slips off M98 bolt	Cocking piece O.K.?	Check/replace bolt body
Bolt assy.	C.P. slips off sear	Sear condition O.K.?	Check sear/rest position
Bolt assy.	C.P. slips off sear	Sear position O.K?	Check/replace cocking piece
Bolt assy.	Slam/impact fires	Sear or cocking piece altered?	Check/replace sear or cocking piece
Bolt assy.	Slam/impact fires	C.P. slides over top of sear?	Check sear engagement/sear spring
Bolt assy.	Slam/impact fires	Sear eng. and spring O.K?	Check/replace altered cocking piece
Bolt assy.	Slam/impact fires	Sear engagement minimal?	Check/adjust vertical sear engagement
Bolt assy.	Slam/impact fires	C.P. eng. ledge damaged?	Check/replace cocking piece
Bolt assy.	Slam/impact fires	C.P. engagement ledge O.K.?	Check /replace weak firing pin spring
Bolt assy	Slam/impact fires	Sear and cocking piece O.K?	Check for loose bolt/sleeve assy. threads
Bolt assy	Slam/impact fires	Bolt assembly threads loose?	Replace bolt sleeve and/or bolt body
Bolt assy.	Slam/impact fires	C.P. jumps over sear?	Check/repl. cocking piece, sear, or spring
Bolt assy.	Slam/impact fires	Custom trigger problem?	Check and adjust trigger
Bolt assy.	Slam/impact fires	Adjustment doesn't help?	Replace trigger sear or assembly
Bolt assy.	M93~96 extract. slips off	Chamber dirty/pitted?	Detail clean/recheck
Bolt assy.	M93~96 extract. slips off	Chamber O.K.?	Check/replace extractor
Bolt assy.	M93~96 extract. slips off	Extractor O.K.?	Check/refit/replace extractor ring
Bolt assy.	M91 extractor slips off	Inside backup stud damaged?	Check/replace M91 backup stud
Bolt assy.	M98 extractor slips off	Bevelled guide damaged?	Check/replace extractor.
Bolt assy.	M98 extractor slips off	Bevelled guide O.K.?	Check guide bevel in bolt body
Bolt assy.	M98 extractor slips off	Bolt guide bevel damaged?	Replace bolt body
Bolt assy.	Face binds cartridge head	Wrong bolt?	Make sure bolt wasn't switched
Bolt assy.	Face binds cartridge head	Case resizing problem?	Check/adjust loading dies
Bolt assy.	Face binds cartridge head	Bolt and dies O.K.?	Clean and Cerrosafe cast chamber
Bolt assy.	Face binds cartridge head	Casting looks normal?	Check chamber with go gauge
Bolt assy.	Face binds cartridge head	Tight on go gauge?	Ream/check with go/no-go gauges
Bolt assy.	Face binds cartridge head	Won't close on go?	Ream/check with go/no-go gauges
Bolt assy.	Closes on no-go gauge	Wrong bolt?	Make sure bolt wasn't switched
Bolt assy.	Closes on no-go gauge	Chamber problem?	Clean and Cerrosafe cast chamber
Bolt assy.	Closes on no-go gauge	Casting looks normal?	Requalify/replace barrel
Bolt assy.	Brass case problems	Cracks, case heads separate?	Cast chamber/check headspace
Bolt assy.	Brass case problems	Chamber oversize?	Requalify/replace barrel
Bolt assy.	Brass case problems	Headspace excessive?	Requalify/replace barrel
Bolt assy.	Brass case problems	Chamber/headspace O.K?	Check for work hardened brass
Bolt assy.	Brass case problems	Brass O.K?	Recheck loading data
Mil. trigger	No return/sticky	Drags in T/G window?	Clearance window/recheck
Mil. trigger	No return/sticky	Trigger lever bent?	Straighten/replace trigger
Mil. trigger	No return/sticky	Trigger too long for T/G?	Shorten or replace trigger lever
Mil. trigger	No return/sticky	Pivot pin problems?	Check/replace pivot pins
Mil. trigger	No return/sticky	Sear spring problem?	Check/replace sear spring
Mil. trigger	No return/sticky	Dirt or oil impacted?	Detail clean/recheck
Mil. trigger	Creeps/drags	Sear/C.P. problem?	Check/polish/replace sear or C.P.
Mil. trigger	2nd stage creeps	2nd stage cam low?	Check/replace trigger lever
Mil. trigger	2nd stage creeps	Altered 2nd stage cam?	Check/replace trigger lever
Mil. trigger	Low sear rest position	1st stage cam high?	Check/adjust/replace trigger lever
Mil. trigger	Slam/impact fires	Sear rest position low?	Check/adjust rest position
Mil. trigger	Slam/impact fires	Sear rest position O.K.?	Check sear/C.P. condition
Mil. trigger	Slam/impact fires	Sear/C.P. both O.K.?	Check/replace sear or firing pin springs
Mil. trigger	Erratic sear release	Pivot pin problem?	Check/replace pivot pin(s)

WHERE?	WHAT IS IT?	CHECK FOR:	REMARK:
Trigger	Stiff/drags	Sear/C.P. problem?	Check/replace sear and/or C.P.
Trigger	Stiff/drags	Sear and C.P. O.K.?	Check/replace sear/trigger spring
Adj. trigger	Stiff/drags	Trigger problem?	Check internal parts, springs/replace
Trigger	Heavy	Wrong spring(s)?	Check/replace spring(s)
Trigger	Heavy	Damaged sear or C.P.?	Check/replace sear and/or C.P.
Trigger	Too light	Low sear rest position?	Check/adjust/replace trigger or sear
Trigger	Too light	Weak sear spring?	Check/replace sear spring
Trigger	Too light	Altered sear/C.P.?	Check/replace sear and/or C.P.
Adj. trigger	Too light	Incorrect adjustment?	Check/readjust
Adj. trigger	Too light	Weak/wrong springs?	Check/replace springs/parts, recheck
Set trigger	Too light	Altered/wrong springs?	Check/replace springs
Trigger	Sear erratic	Loose on pivot pin(s)?	Replace pin(s), recheck
Trigger	Sear erratic	Sear engagement low?	Check engagement/adjust/replace sear
Adj. trigger	Sear erratic	Mounting screw loose?	Tighten/locktite mounting screw
Adj. trigger	Sear erratic	Mounting screw damage?	Replace screw if trigger body O.K.
Adj. trigger	Sear erratic	Trig. body thd. damage?	Replace trigger assembly

Note 1: A number of manufacturers have made military two stage triggers, commercial adjustable single stage triggers, and adjustable set triggers for Mauser actions. Consult manufacturer's adjustment instructions and minimum pull specifications where available. Trigger installation, adjustment, and mechanical condition must not permit slam-fires, impact fires, or safety-off fires. Trigger pull must not be so light that the trigger could be released before the rifle is fully on target.

Note 2: Military type bolt sleeves and firing pin safety levers are not found on most late M98 commercial sporters. However, the safest possible trigger/safety combination would include a military firing pin safety lever to control the firing pin and, if an other than military trigger is installed, an additional trigger block safety to control the trigger.

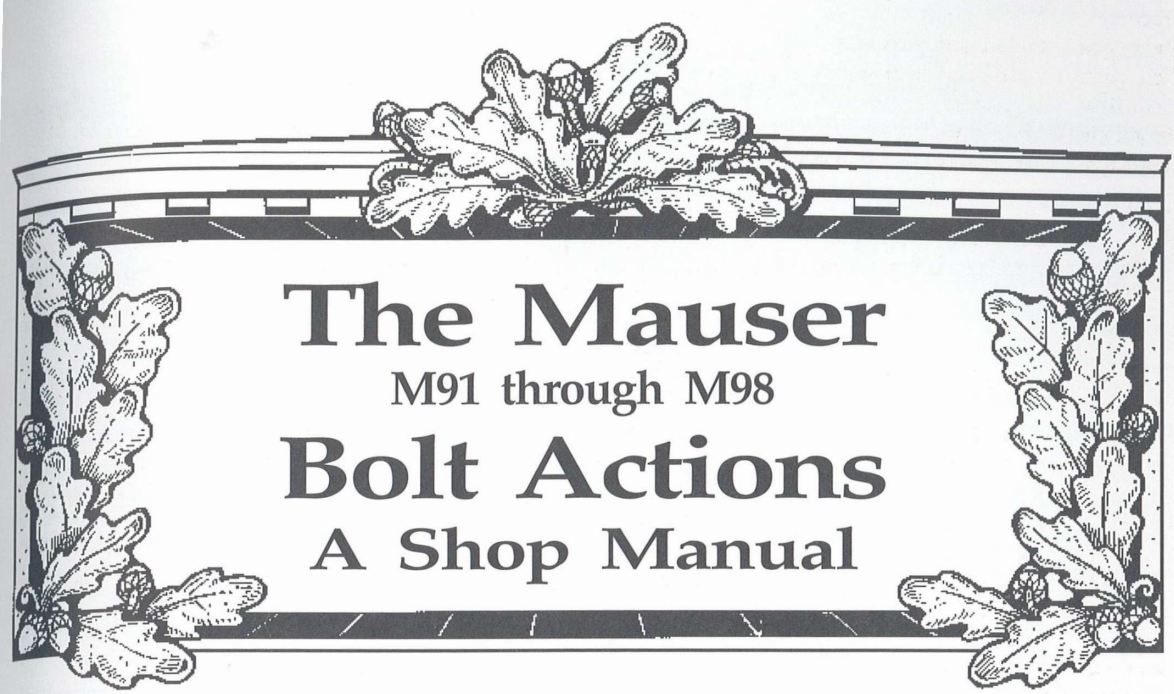
Note 3: Trigger and safety system combinations that come across the bench will vary considerably. For that reason, the possible problems listed are general. Always consult manufacturers' instructions and adjustment data when checking out custom and/or accessory triggers. Do not skip trigger pull, safety function, slam fire, impact fire, and safety-off fire checks.

Receiver	Binds/drags bolt	Receiver tweaked/warped?	Check concentricity with mandrel
Receiver	Binds/drags bolt	Slightly warped?	Straighten or replace receiver
Receiver	Binds/drags bolt	More than slightly warped?	Replace receiver
Receiver	Binds/drags bolt	Stretched or cracked?	Replace receiver
Receiver	Binds/drags bolt	Front ring out of round?	Replace receiver
Receiver	Binds/drags bolt	Guide/lugways rough?	Hone bolt guide/lugways
Receiver	Mounting thds. damaged	Can be cleaned?	Chase with .250"-22 tap
Receiver	Mounting thds. damaged	Not cleanable?	Install thread insert/replace receiver
Receiver	Lug area setback	Less than .002"?	Lap bolt/receiver lugs or replace receiver
Receiver	Lug area setback	More than .002"?	Resurface/reheat treat/ or replace receiver
Receiver	Ctg. feeding drag	Extractor claw tight?	Adjust/replace extractor
Receiver	Ctg. feeding drag	Magazine rails tight?	Check/adjust rails
Receiver	Ctg. feeding drag	Magazine rails O.K?	Check/expand magazine box
Receiver	Ctg. feeding drag	Ramp rough?	Polish ramp- don't undersize
Receiver	Magazine binds ctg.	Magazine rails tight?	Adjust rails and recheck
Receiver	Magazine binds ctg.	Magazine rails O.K?	Check for wide rib on follower
Receiver	Magazine hard to load	Follower rib hits?	Clearance rib/rails and recheck
Receiver	Magazine hard to load	Follower rough?	Polish edges of follower
Receiver	Magazine hard to load	Follower rib wide?	Adjust or replace follower
Receiver	Magazine hard to load	Magazine rails tight?	Check/adjust rails and recheck
Receiver	Barrel loose	Barrel torque problem?	Check/requalify barrel
Receiver	Barrel loose	Barrel thread problem?	Check/replace barrel
Receiver	Barrel loose	Barrel threads O.K?	Check/replace receiver
Receiver	Rusty	Light exterior pits?	Sand or bead blast/refinish
Receiver	Rusted, pitted	More than light pits?	Replace receiver
Receiver	Finish worn	Otherwise O.K?	Polish/reblue
Receiver	Barrel hard to remove	Possible crack?	Magnuflux check receiver
Receiver	Cracked	No further check.	Replace receiver
Receiver	Altered	No further checks.	Replace receiver

WHERE?	WHAT IS IT?	CHECK FOR:	REMARK:
Rear sight	Not at 12:00	Barrel sleeve problem?	Align sleeve and resolder
Rear sight	Sight blade damaged	Elevator leaf O.K?	Replace sight blade
Rear sight	Sight blade damaged	Blade and leaf integral?	Replace blade/leaf assembly
Rear sight	Inaccurate	Elevator pivot loose?	Replace pivot pin and/or elevator
Rear sight	Inaccurate	Elevator leaf bent?	Straighten/replace elevator leaf
Rear sight	Bullet impact high/low	Wrong blade or elevator?	Check/replace parts
Front sight	Not at 12:00	Barrel sleeve problem?	Align sleeve and resolder
Front sight	Bullet impact high/low	Wrong front blade?	Check/replace blade
Front sight	Bullet impact right/left	Blade dovetail O.K.?	Drift blade to correct point of impact
Front sight	Loose	Blade dovetail O.K.?	Replace sight blade
Front sight	Loose	Sight blade O.K.?	Replace barrel sleeve/sight base
The Rifle	Inaccurate	Receiver loose/stressed?	Install rear spacer/bed receiver
The Rifle	Inaccurate	Barrel nonconcentric?	Check/replace barrel
The Rifle	Inaccurate	Barrel external stress?	Bed receiver/clearance forestock
The Rifle	Inaccurate	Barrel vibration?	Apply barrel dampening at forestock
The Rifle	Inaccurate	Bore worn/oversize?	Cast or slug barrel/replace worn barrel
The Rifle	Inaccurate	Bore undersize?	Cast or slug/replace barrel
The Rifle	Inaccurate	Bore irregular?	Replace barrel
The Rifle	Inaccurate	Chamber throat problem?	Requal./replace barrel/recut chamber
The Rifle	Inaccurate	Excessive headspace?	Gauge check/requalify/replace barrel
The Rifle	Inaccurate	Headspace O.K.?	Check for ignition problems
The Rifle	Inaccurate	F.P. protrusion short?	Check/replace firing pin
The Rifle	Inaccurate	F.P. punctures primers?	Adjust/replace firing pin
The Rifle	Inaccurate	F.P. port oversize?	Check/replace bolt body
The Rifle	Inaccurate	Erratic ignition?	Check for weak firing pin spring
The Rifle	Inaccurate	Erratic ignition	Check for bent firing pin tip
The Rifle	Inaccurate	Ammo/primer problem?	Replace ammunition lot
The Rifle	Inaccurate	Ammo/primer problem?	Inspect reloading components
The Rifle	Inaccurate	Ammunition problem?	Review reloading procedure
The Rifle	Inaccurate	Sight(s) on angle?	Straighten/replace sight(s)
The Rifle	Inaccurate	Shoots high/low?	Adjust/replace rear sight
The Rifle	Inaccurate	Shoots left/right?	Adjust/replace front sight
The Rifle	Inaccurate	Crown miscut/damaged?	Recut/lap muzzle crown
The Rifle	Misfires	Firing pin short?	Replace firing pin
The Rifle	Misfires	Firing pin bent?	Straighten/replace firing pin
The Rifle	Misfires	F.P. port oversize?	Replace bolt body
The Rifle	Misfires	Headspace problem?	Requalify/replace barrel
The Rifle	Misfires	F.P. spring short/weak?	Replace firing pin spring
Bullets	Deform	Eroded or long throat?	Requalify/replace barrel
Bullets	Deform	Irregular bore?	Replace barrel
Bullets	Deform/deflect	Muzzle crown problem?	Recut, lap muzzle crown
Bullets	Keyhole	Muzzle crown problem?	Recut, lap muzzle crown
Bullets	Keyhole	Over diameter bore?	Replace barrel
Bullets	Keyhole	Slow twist rate?	Use correct bullet/velocity
Bullets	Keyhole	Wrong twist rate?	Replace barrel
Bullets	Keyhole	Wrong bullet for twist?	Change bullet weight

Note: This troubleshooting section is included to provide assistance in solving problems found in Mauser M91~M98 rifle actions. Other problems and combinations of problems are possible which could have causes and remedies that may not be listed in this guide. Tolerance accumulation and worn, misfit, or wrong parts can cause unusual malfunctions and problems. Keep an open mind when troubleshooting any action mechanism. Carefully investigate all possible causes for any problem or malfunction before beginning repairs.

Bolt replacement warning: bolt body replacement is suggested or discussed as a correct remedy under the remarks heading in several instances above. Remember that bolt replacement always directly affects headspace. When bolts are replaced, with few exceptions, barrels must be either requalified or replaced and chambers reamed to correct headspace.



SECTION II

Editor's Note:

Jerry Kuhnhausen has written a number of detailed shop manuals on the basics of riflesmithing as it relates to troubleshooting; parts fitting; general repair; action work; custom work; rebarrelling, and rebuilding of bolt action mechanisms. In the Mauser line, these books covered the M91 and M92, M93 and M95 (the Spanish Mausers), M94 and M96 (the Swedish Mausers), and the M98's, including most M98 variations made by Mauser, pre-WW II affiliates, and WW II manufacturers.

Mauser 1889 through 1898 rifle actions form a distinct group in several respects: 1. Before the M89, all Mauser actions were designed for rimmed black powder cartridges. 2. Beginning with the 1889 model, Mauser rifles/actions were designed to chamber the, then new, rimless type, smokeless powder cartridges. 3. Mauser M89~M98 actions share many common features, and are visually similar.

M89 and M90 Mauser actions closely resemble the later M91 (Argentine) Mauser action, with which this manual begins. In the U.S., M89 and M90 rifles and carbines have been of interest primarily to military rifle collectors, and are very rarely seen by gunsmiths. By contrast, large quantities of M91 Argentine Mausers have been imported and are probably still in use. For these reasons, this book, **The Mauser M91~M98 Bolt Actions, A Shop Manual**, focuses on and combines the author's data on the M91 through M98 bolt actions.

Section I covers detailed inspections, parts checks, general parts fitting, assembly, and basic repairs. The "Troubleshooting Guide", included at the end of the section, is retained from the author's original shop manuals. The Troubleshooting Guide is an easy basic reference, regardless of individual experience level.

In editing Section II, we have included an assortment of Mauser action work taken from the author's original loose-leaf manuals. This section includes additional parts replacement data and details on some of the most frequently asked for shop riflesmithing work. As in Section I, necessary hand and shop tools are shown with the work as it is being done.

Bench and shop work shown and discussed in this manual parallels standard industry service procedures as closely as possible, except where precision repair and custom work requires special fixtures or special tooling. Metallurgical information is based on historical references, half and cross sectioned Mauser parts, receivers and bolts, confirming spectroanalysis of metal specimens, and data from experts in the commercial heat treating field.

The parts and fitting data given in this book was gathered from a combination of sources: old drawings, measurements of original parts, surplus military parts, new parts (where available), and accessory replacement parts. Unaltered older Mauser actions were also disassembled and parts/receivers measured for possible dimension changes caused by wear, etc. From such measurements, we can get a good idea of original manufacturing tolerances and workable limits.

The time when M91~M98 factory repair data was available is long gone, yet millions of these rifles are still in use. Currently, at least 95% of the repair and custom work on Mauser actions is done by independent gunsmiths with little parts replacement information, fitting data, max./min. specifications, and related safety warnings. The author believes this lack of information is a disservice to riflesmiths and rifle owners alike, and will ultimately effect the entire firearms industry. In this book, the author stresses available original and industry standard specifications. Industry standard headspace and chamber specifications are given because they are more conservative than military field standards. The author believes that specifications, cautions, and safety warnings should be widely disseminated so that safety inspections might be made before the fact of an accident or injury.

With Sections I and II of the **The Mauser M91~M98 Bolt Actions, A Shop Manual**, you have at hand more detailed information about the workings of Mauser's excellent bolt actions than has ever been published before.

A Few Important Words About Custom Riflesmithing Work . . .

Times have changed for the craftsman. These days, in the U.S., if you restore military rifles, do custom work, accessory trigger installation, bolt modification, rebarrelling, chambering, wildcat chambering, custom rifle building, and certain other gunsmithing work, you brush shoulders with a bad dream come true called product liability, in much the same way as would a firearms manufacturer. If you aren't already familiar with this subject, you might find it worthwhile to talk it over with your attorney. Product liability could be defined as "the modern road to riches". With the help of crafty lawyers, more and more of the undeserving are retiring early- and on your hard earned insurance dollars.

1. Remember that custom gunsmithing is creative and requires a certain amount of planning and precision machine work. It is, to that extent, different from basic mechanical repair work. In this field, you are the designer.

2. Always begin with receivers and action parts that are fully serviceable and in excellent cosmetic condition. Use the best quality barrels, triggers, sights and sight mounting systems. Anything less is seldom worth the labor cost involved in fitting and installing the component.

3. When doing machine work, make all set-ups carefully and on a strictly individual basis. Remember that plus/minus tolerances are common in all mass produced products. No two parts are ever precisely the same. Always recheck set-ups before beginning machine work.

4. Do only custom work that you know is properly useful and safe. Turn down odd requests for things such as excessively light trigger pull, overly narrow trigger guards, under diameter (too thin) barrels, excessively lightened receivers, cartridge chamberings that would be questionable in certain receivers, etc.

5. Replace worn, misfit, altered, or mismatched safety parts. Always check and recheck safety system function. In my opinion, firing pin safety systems are more positive than trigger block safety systems. When building custom rifles on M98 actions, I would suggest using either a military type bolt sleeve with a low accessory firing pin safety lever for scope clearance, or installing a custom bolt sleeve with side mounted three position M70 style safety lever.

6. Always check and recheck firing mechanisms for possible impact fires, slam fires, and/or safety-off fires.

7. Always cast unknown chambers and bores with Cerrosafe casting metal to positively identify the chamber and determine chamber and bore diameters.

8. Always closely inspect barrel bores in both new and older barrels.

9. Always check headspace and stamp barrels with caliber/chamber designation.

10. Turn down every "opportunity" to perform low quality work. Whatever work you accept, do it well. However small, every job you do becomes a part of your reputation.

11. Do only the highest quality custom work. Price your work accordingly- as high quality work. In this way, you will develop only a quality clientele.

12. Be selective; work only for those who can appreciate fine gunsmithing. Remember that high quality custom riflesmithing goes far beyond simple craftsmanship; somewhere along the line, it becomes an art form.

The very best things always have been made by hand: the best automobiles, the finest sporting rifles, and the most accurate match grade and varmint rifles. When properly cared for, a quality, hand crafted firearm will last for generations.

About Mauser Military Sights and Sight Differences-

A number of different sights and sight assembly variations are found on Mauser rifles and carbines. Different sights are sometimes found on rifles and carbines of similar model type. Usually, these variations reflect basic changes in government order specifications. Other differences are accounted for by downstream factory, arsenal, and service depot refurbishments. Barrel assembly and sight changes (and sight assembly or tangent elevator mix-ups) made by arms exporters, importers, and individuals would generally explain the remainder.
Standard, commonly found Mauser military rifle and carbine rear sight types are shown in figures 140 through 143. In addition to these, a great number of other variations have been manufactured, including the stepped elevator and wheel elevator type sights found on some M96 Swedish rifles and the many civilian versions of the tangent military sight that were custom made and used on early Oberndorf commercial sporting rifles.

Collectible Rifles & Carbines
Ideally, front and rear sights on collectible Mauser military rifles should be correct for the particular model and fully serviceable. For historical and sight identification data, see Ludwig Olson's Mauser Bolt Rifles. Limit work on correct, original sights to replacing worn or damaged parts. Maintain rifle collector value by using only correct original sight parts.
With the exception of collectibles, mentioned above, Mauser military rifle and carbine sights are discussed in this section purely from the viewpoint of correcting a mechanical or zero problem that would prevent a rifle in otherwise good condition from printing on target correctly.

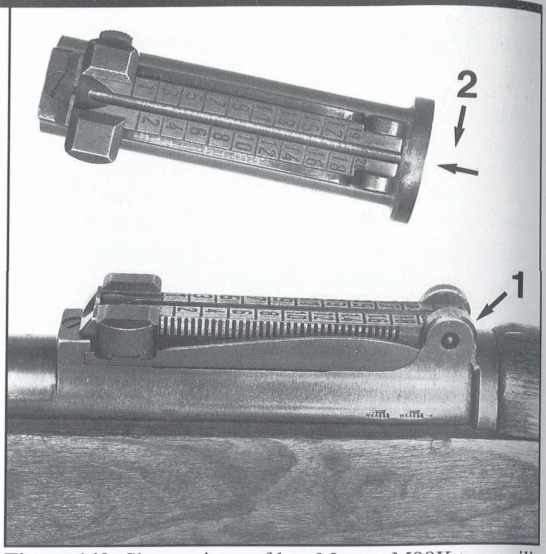


Figure 140- Shows views of late Mauser M98K type military rear sights. This sight is identified by its 100 meter minimum zero and finer elevator detents. The elevator leaf and tangential elevator ramp are removed by first drifting out the retaining pin, shown at **1**, and then pushing down on and simultaneously pulling back the elevator leaf, as shown at **2**. The elevator ramp/spring then lifts up and out of the sleeve.

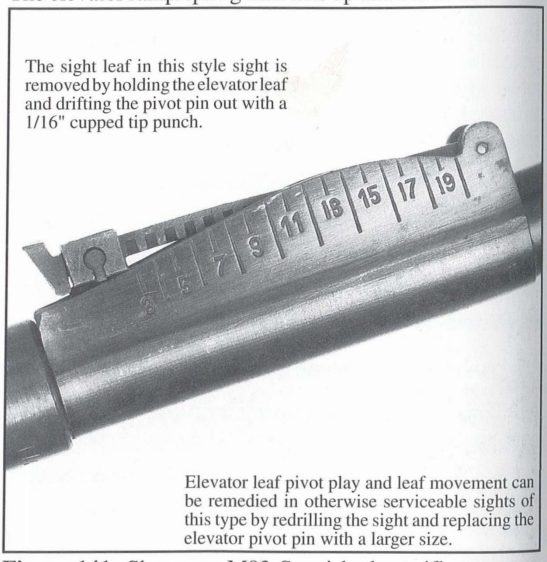


Figure 141- Shows an M93 Spanish short rifle type rear sight with integral barrel sleeve and tangential elevator ramp. This sight has been found on Spanish M95 carbines and M1916 7.62 CETME conversions imported into the U.S. The shortcoming of this economy design is that the elevator pivot wears easily and permits considerable elevator leaf movement.

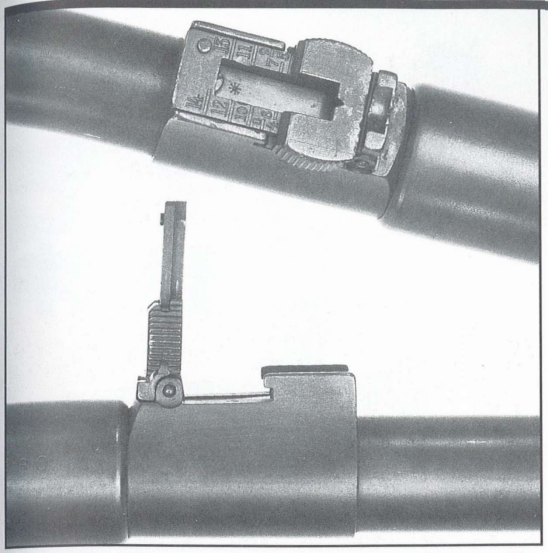


Figure 142- Shows top and side views of a combination flip-up leaf type sight on a Mauser M91 Argentine carbine barrel. Variations of this sight are found on some M91, M92 and M93 Spanish rifles, M94 and M96 Swedish carbines/rifles, and on some M94 (non-Swedish), M95, and other contract rifles. Stop screw at end of the leaf retains the elevator slider.

The Lange type rear sight is easily identified by its reversed tangential grooves on either side of the elevator leaf. The Lange elevator slider tracks and locks into detents in the keyway machined into the barrel sleeve body.

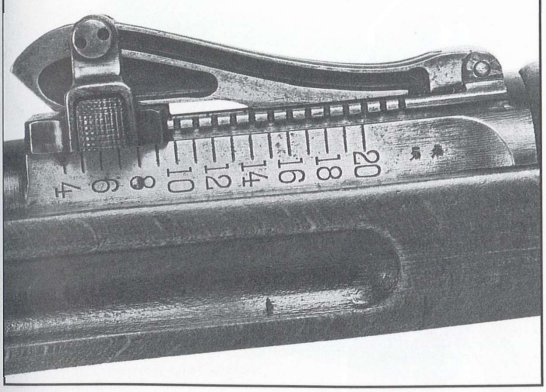


Figure 143- Shows a Lange type rear sight used through WW I on German M98 military rifles. This sight also can be found on some early contract rifles and refits. Several variations were made, including a short version for carbines and models that were calibrated for early M88 type 7.9mm ammunition and later S type 7.9mm ammunition.

About Mauser Miltary Rifle Sights and Service Cartridges-

Sights on Mauser 6.5mm, 7mm, 7.65mm, and 7.9mm military rifles, short rifles, and carbines were calibrated to match the trajectory curves produced when standard military service cartridges were fired in the particular model. Bullet type, trajectory, and sight radius were taken into consideration. Because performance and trajectory vary with barrel length and the individual service cartridge, we find long and short rear sights, different elevator curves, and different elevation graduations on the rear sights for the various models.

Service cartridge changes, such as the update from the original 7.9mm M88 type cartridge to the 7.9mm S type, made different sight elevation calibrations and replacement tangential elevator ramps necessary.

Trajectories produced by most commercial and hand loaded ammunition do not exactly agree with the elevation calibrations on most military sights. Consult exterior ballistics tables in a current Speer reloading manual for data on bullet trajectories.

Sight Condition & Usability

Mauser military sights can be considered serviceable if both are undamaged, mechanically tight, mounted in the 12:00 o'clock position, and target grouping agrees with the zero and elevation graduations marked on the rear sight when the correct type service ammunition is fired.

A military rear sight used on a sporter conversion can be easily adjusted to a closer zero by installing a taller front blade and adjusting blade height to the desired zero range. See adjustable test sight shown in figure 147. Bending an elevator leaf to reduce zero is not a workable solution; the resulting curve can make sight elevation unpredictable at other points on the leaf. Straighten bent sight leaves as discussed in figure 144.

I would suggest using an M98K sight when a military type rear sight is desired on a sporter conversion. This sight is finely graduated from 100 to 2000 meters. Closely graduated elevation detents permit fine elevation adjustments. See views in figure 140.

Military Sight Problems and Solutions

The most often found problems with military sights are mechanical damage, surface corrosion, loose elevator pivots, rotated barrel sleeves, and mismatched parts. Replace rusted, pitted, or damaged sight parts or sight assemblies.

Bent Elevator Leaves

A slightly bent elevator leaf can be repaired by removing the leaf and squeezing it in a vise between 1/8" aluminum strips, or by placing the leaf on a trued bench block and lightly tapping the high area and remaining high spots with a lead hammer until the leaf is straight. The edge of a machinist scale makes an acceptable straightness gauge.

Worn and Loose Elevator Pivots

Older integral barrel sleeve/tangent elevator ramp type sights, as shown in figure 141, are often found with loose sight leaf pivots.

Worn or otherwise loose elevator pivots will permit sight leaf wobble and/or lateral rear sight blade movement. This condition can cause erratic and left-right bullet impacts on target. If the barrel sleeve and sight assembly are in otherwise serviceable condition, redrill the sight leaf and barrel sleeve pivot holes to the next pin size and install a replacement pivot pin.

Stuck or Resistant Elevator Slider

If the elevator slider assembly is resistant or stuck on the sight leaf, it could be impacted with accumulated dirt and dried lubricant. Soak the assembly in solvent, then disassemble and detail clean the parts. Use caution to prevent loss of lock plunger springs. See figure 144.

A bent slider body and/or rough sight leaf can also make the slider resistant and hard to move.

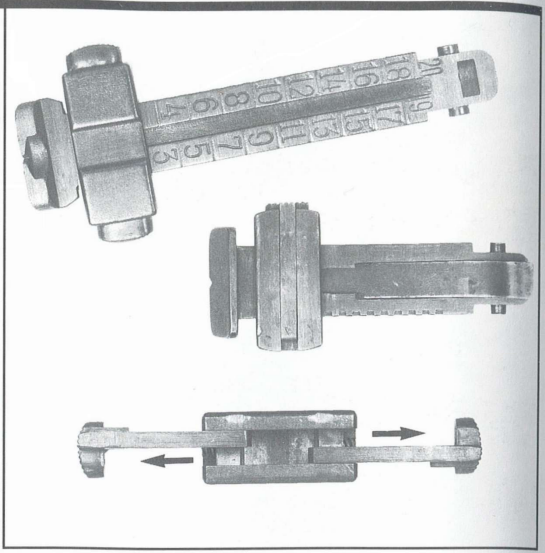


Figure 144- Shows standard and integral spring type M98 sight leaf/elevator slider assemblies after removal from the barrel sleeve. Elevator sliders are removed by depressing the lock button and pulling forward off the leaf. A slightly bent leaf can be straightened with a soft hammer or by squeezing between aluminum plates in a bench vise. Slider disassembly is shown, below. Use care to prevent spring loss.

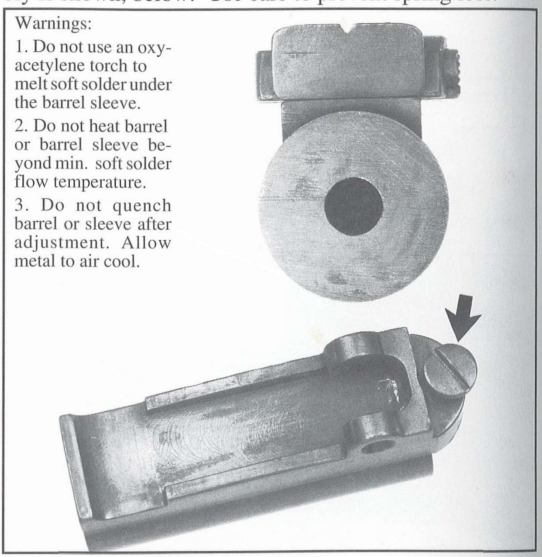


Figure 145- Installed sight/barrel sleeve, shown at top, is in correct 12:00 o'clock position. The rear sight barrel sleeve, shown below, has sight leaf assembly, tangent elevator, and elevator spring removed in preparation for adjustment to 12:00 o'clock position. Remove set screw, see arrow above, before attempting to move the barrel sleeve.

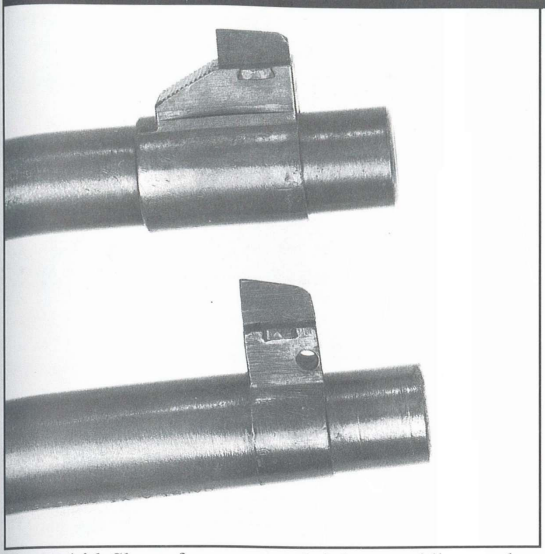
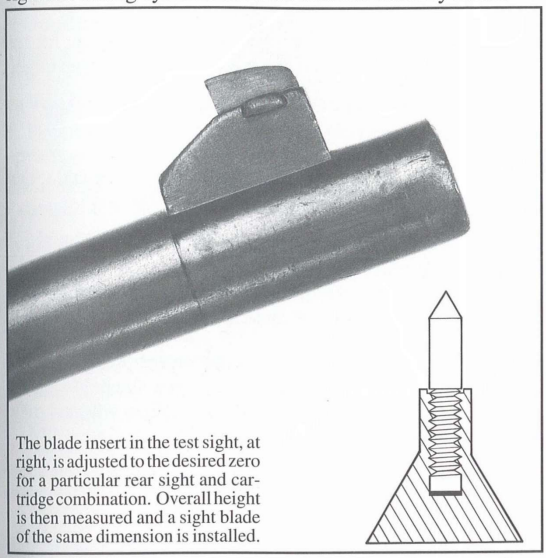


Figure 146- Shows front ramp and sight assemblies on a late M98K, at top, and an intermediate M95 (Spanish) carbine. When installed, the sleeve/sight base is positioned at 12:00 o'clock and secured with the set screw under the sight dovetail slot. The sleeve is then sweated to the barrel with soft solder. The examples above are the most common front sight mounting systems used on Mauser military rifles.



The blade insert in the test sight, at right, is adjusted to the desired zero for a particular rear sight and cartridge combination. Overall height is then measured and a sight blade of the same dimension is installed.

Figure 147- Shows a long sweat-on sleeve/ramp used on some M98 contract rifles. Note joint at back of ramp. Extra caution must be used to prevent damage when repositioning this thin sleeve. A set screw is located inside the sight blade dovetail, as with other ramps. The illustration, below, shows an adjustable test sight useful in determining correct front sight blade height for a particular rear sight.

Military Sight Problems and Solutions, Continued

Slightly bent slider bodies can be straightened by sliping the slider body over a small flat bar and lightly peening the exterior. Replace slider bodies that will not straighten easily or that are corroded on the inside. Deburr and level any rough spots found on the elevator leaf before reassembling.

Loose Elevator Slider

If the elevator slider is loose when installed on the leaf, the lock detent spring or springs may be weak. Replacing the slider lock detent spring(s) and detail cleaning the slider body and detent lock(s) will solve this problem in many cases. If slider looseness is caused by slider body wear, lock plunger wear, or elevator detent wear, replace the worn part or parts.

Rotated Sights/Barrel Sleeves

If sights are not at top dead center, see figures 145 & 146. Check for overly deep set screw holes when repositioning sights. Suggested set screw hole depth limit is .050".

Sight and Sight Part Mismatches

Mismatches are the second most commonly found problem associated with surplus military rifle sights. Depending on the mismatch, the effect on target can be minor or severe. See pages 128 and 129. When mismatches are unworkable, the best remedy is to install the correct sights. A mismatched front sight base problem is usually easily remedied by installing a shorter or taller front blade or adjusting front blade height. See fig. 147. If front sight blade adjustment or substitution will not handle the problem, install the correct front barrel sleeve/sight base and front sight blade.

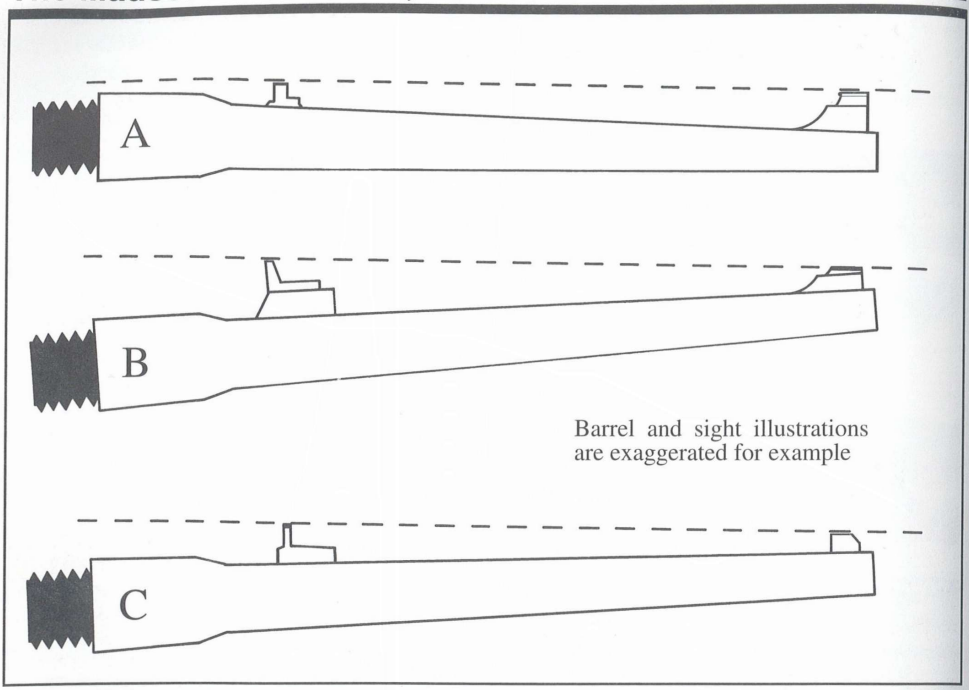


Figure 148- Illustrations show mismatched, high and low front and rear open sights and open sights that are too low in profile. The barrel shown at **A** has a front sight that is too high. This barrel would shoot much too low. The barrel at **B** has a front sight that is low. This barrel would shoot much too high. The barrel at **C** has sights that are basically functional; i.e the front and rear sights are of the correct height, relative to each other. But, in this example, sight profile would be too low for the trajectory of a medium velocity bullet of low ballistic efficiency fired at a medium or long range target.

Practical usability of open sights on hunting rifles and carbines naturally decreases with range. As distance to a target increases, two problems begin to appear:

1. **Perspective limitation**: as range to the target increases, the apparent size of the target and target kill zone decrease, relative to the sights. At some point, the front sight will cover the target.

2. **Elevation limitation**: when the rear sight and barrel are elevated to place a medium velocity bullet of low ballistic efficiency at a desired medium or long range point of impact, the front sight and the barrel may be elevated so high that view of the target is entirely blocked. Low sight profile, bullet trajectory, and range to target are factors that combine to create this problem.

To some extent, these factors can be overcome by using higher sights on the barrel (a higher sight profile) and a longer minimum elevation (zero) setting. In this way, sight picture can be held slightly under the target to maintain visibility. Bullets used in most modern medium high velocity rifle cartridges are ballistically efficient enough to make this workable. See illustration in figure 149.

Long range rifles (500+ yards) require either greater than normal sight elevation adjustment or sight geometry that compensates for additional bullet drop.

Barrel mounted open sights that are well installed and correctly matched to the user's hunting and range requirements are especially useful on short to medium range (50-300 yard) rifles and carbines. However, open sights tend not to be "user friendly" to individuals with vision problems. Many far sighted individuals see targets clearly but have problems with blurry or fuzzy sight pictures. Near sighted individuals have the reverse problem. Other individuals may perceive target size as being much too small versus the sights or find sight picture and target resolution questionable even at shorter ranges. According to many devoted shooters over 40, glasses may, or may not, correct these problems. In many cases, aperture (peep) sights or telescopic sights are the only remedy. See figures 152 ~162.

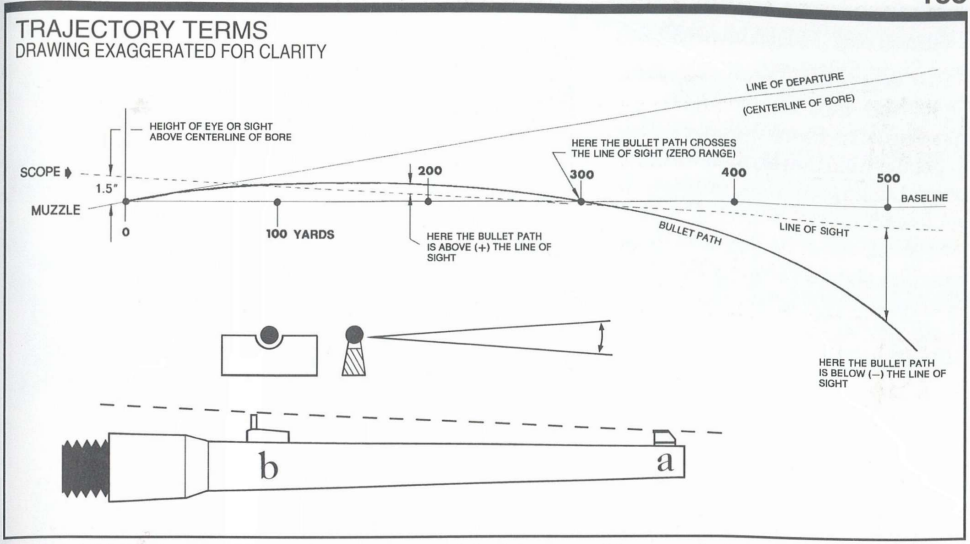


Figure 149- Trajectory illustration, at top, used in this manual by permission of **Speer Bullet Operations**, Sporting Equipment Division of Blount, Inc., has a purposely exaggerated trajectory curve which permits bullet path relative to sighting line to be easily visualized. Actual trajectories will vary with bullet ballistic coefficient, muzzle velocity, and other factors. For trajectory data concerning a particular bullet at a given muzzle velocity, consult exterior ballistic tables in bullet manufacturers current reloading data manual. The barrel illustration, at bottom, shows typical sight locations. Barrel diameter and sight measuring reference points, shown at **A** and **B**, are used when selecting open rifle sights for medium range rifles. The sight drawing at center depicts sight line divergence as it would relate to a change in front sight height or a change in distance beween the sights. Also see page 134.

Estimating Open Sight Height-

There are several fairly involved procedures for determining sight heights on tapered or step/tapered rifle barrels. The following height estimating method automatically takes sight radius into consideration by locating the sights before measurements are made, and is the simplest I've seen.

1. Determine exact front and rear sight position on the barrel and mark the location. Usually, the best open rear sight position is about 4 1/4" forward of the barrel/receiver thread junction.

2. Measure barrel O.D. at **A** where the front sight is to be installed. Divide this measurement in half. Example: a .600" muzzle O.D. measurement divided by 2 would be .300".

3. Measure barrel O.D. at **B** where the rear sight is to be installed and divide that measurement in half. Example: a .900" O.D. measurement divided by 2 would be .450"

4. Select the adjustable rear sight to be used and measure sight height from the radius at the bottom of the base to the top of the blade notch (but do not include side extensions above the top of the notch). **Note**: With a **Williams WGOS** sight and a 3/8" blade, sight height would be approx. .586" (with the sight at the approx. center of elevation adjustment).

5. Add the rear sight height measurement found at #4 to the barrel dimension at #3 to get rear sight height relative to the centerline of the bore. Example: .586" + .450" = 1.036"

6. Now, subtract half of barrel O.D. at front sight position, as found in #2, from the height of the rear sight above barrel centerline as calculated in step #5. Example: 1.036"-.300" =.736". This indicates that a front sight ramp/front blade combination must be in the .736" height range to accommodate the rear sight. Consult sight manufacturer's selection charts for a sight ramp/front sight blade combination in the required height range.

Presetting the rear sight at the mid-elevation point, as discussed above, is a conservative step that helps compensate for computation errors. This also provides additional rear sight elevation adjustment if needed. Sight elevation adjustment is useful only from the minimum desired zero point up.

When it is desirable to set up open sights on a hunting rifle with maximum sight elevation adjustment, make sight height calculations based on the height of the rear sight when set at minimum elevation. With min. zero coincident with rear sight lowest elevation adjustment, further fine tuning would be made at the front sight. The adjustable test sight shown in fig.147 is particularly useful for this purpose.

Commercial Mechanical Sights and Sight Selection

Open and mechanical sights for sporting rifles should be selected for a specific field use; short or medium range hunting; hunting in brush or open country, etc. Cartridge ballistics, stock comb height, and other variables should be taken into consideration. For example, the combination of a medium range, low ballistic efficiency cartridge and a high stock comb would make a somewhat higher than normal sighting line (a higher sight profile) necessary. Although often the last thing thought about, eyesight is an important factor in sight selection. Open sights may not be suitable for individuals who have vision problems. In such cases, receiver mounted sights, such as those shown in figures 152 and 153, or telescopic sights, as discussed on pages 140 through 142 would be suggested. Once basic mechanical sight style has been selected, and sight profile has been determined, mechanical sights can be selected and installed. See figs. 154~159 before drilling and tapping the barrel or receiver.

Tuning Front Sight Blade Height

The effect of a change in front sight blade height (how much point of impact on target would be raised or lowered at a given yardage) depends on the distance between the front and rear sights and cartridge exterior ballistics.

For the sake of discussion, consider that a fixed point inside the rear sight notch is the point of sight line origin. For round figures' sake, let's also say that the distance between the sights measures exactly 24 inches. With these two factors as given, if the height of the front sight blade was changed by .010", the rate of divergence of the old versus the new sighting lines through the front sight bead would equal .005" per foot. At this rate, an 1/8" (.125")-



Figure 150- Shows a **Williams WGOS** adjustable rear sight. The WGOS is made in base radius sizes to fit most barrels. Interchangeable blades are made in four styles and in 3/16", 1/4", 5/16" and 3/8" heights. Lowest elevation (with a 3/16" blade) is .369"; and highest (with a 3/8" blade) is .617". The WGOS Special is .100" higher than the standard models.

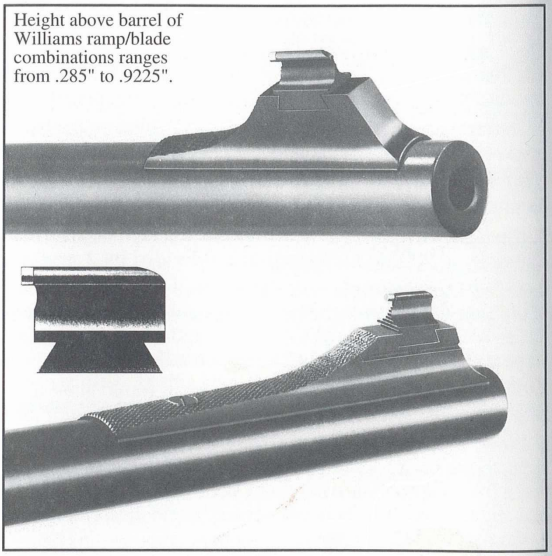
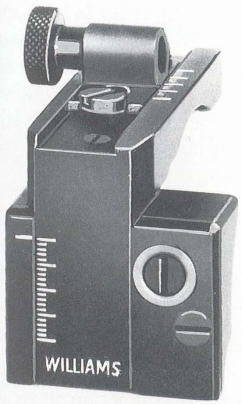


Figure 151- Shows a **Williams "Shorty" ramp** sweated on the rifle barrel at top. A Williams Streamlined ramp (screw-on type) is shown on the barrel below. Williams ramps are made in a wide range of heights. A **Streamlined** front sight, as shown at center, is installed on both ramps. White, gold, and fluorescent bead styles are available.

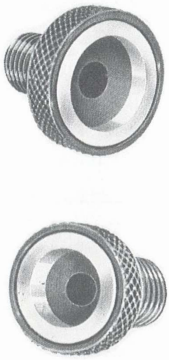


Consult Williams application data for FN Mauser and other sights.

Figure 152- Shows a **Williams FP-98** receiver sight installed on an M98 sporter, at top. A close view of a Williams FP Series sight is shown, below. FP Series sights have micrometer adjustments with positive windage and elevation detents. The **Williams FP-98 TK** sight (not shown) has knurled, target style windage and elevation adjusting knobs.



The Williams 5D-JEMS receiver sight can be installed on M91~M98 Mausers and several other rifles.



Williams Twilight Series apertures shown.

Figure 153- Shows a **Williams 5D-JEMS** receiver sight. The 5D sight was designed for basic hunting use and is fully adjustable for windage and elevation but doesn't have micrometer windage and elevation adjustments. Threaded 3/8" and 1/2" O.D. eye pieces are available for the 5D and FP series sights. Aperture sizes are .050", .093", and .125".

Mechanical Sights, Continued-

change in front blade height would create a sight line divergence of 1.875" at 100 yards, 3.75" at 200 yards, 5.625" at 300 yards, 7.50" at 400 yards, and so on.

The following formula can be used to estimate the effect of a change in front sight height:

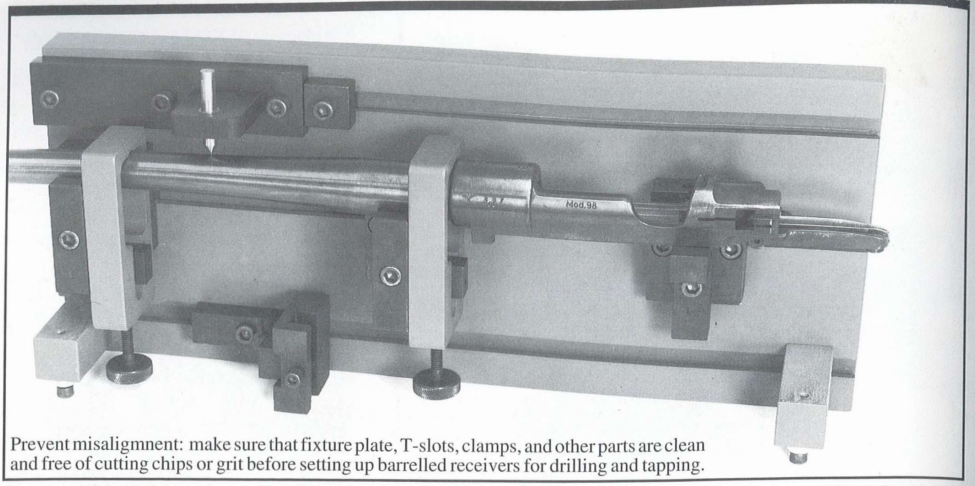
1. Divide the amount of height change in thousandths of an inch by the sight radius in decimals of feet to get divergence rate per foot. (1" for example, equals 1/12 ft. or approx .0834 ft. when rounded off.)
2. Multiply divergence per foot by the distance in feet to the target (or the desired minimum zero point) to get the amount in inches that a sighting line would change over a given distance.
3. When amount of change in inches is compared with bullet path data given in an exterior ballistics table, the result can be used to estimate the front blade height or height adjustment needed to zero the sights at any desired yardage. This method is also useful when the elevation adjustment range of an already installed rear sight is limited.

About Receiver Sights-

The curved right side of the receiver bridge is the only available place to mount a receiver sight on a Mauser M91~M98 action. Fortunately, this location is ideal. See installed Williams sight in figure 152.

Receiver sights must be carefully installed so that the sight bridge is perfectly level. If the sight is even slightly canted, windage adjustments will affect elevation. See page 137 for installation data.

Receiver sights typically have a greater range of elevation adjustment than other mechanical sights. For this reason, initial zero can be hard to find with some sight combinations. Bore sighting is a helpful shortcut. If a receiver sight does not have a zero set screw or stop screw, mark zero position with a reference dot on the sight elevation scale.



Prevent misaligmnent: make sure that fixture plate, T-slots, clamps, and other parts are clean and free of cutting chips or grit before setting up barrelled receivers for drilling and tapping.

Figure 154- Shows a barrelled Mauser receiver set up on a **Brownells/Power Custom SSR Mounting Fixture** to drill and tap a sporter barrel for installation of an adjustable open rear sight. The **SSR** fixture can be used on a mill or drill press table to mount open sights on rifle barrels; scope bases on receivers; sight beads on shotguns, and sights and sight ribs on handguns. When correctly adjusted, this fixture insures that sight mounting holes are drilled exactly at top dead center and in agreement with bore centerline.

With all sight and scope base mounting fixtures, setups must be made with care. Be sure that the barrel and receiver are not rolled to one side or tilted longitudinally so that mounting holes will be drilled at precisely 90° to bore/receiver centerline. If a drill press is used, the table must be at 90° to the quill in both planes. Milling machine heads must be set at precisely 90° to the table.

1. Before drilling or tapping, lay out desired sight position on barrel with Dykem Blue.

2. Set up barrelled Mauser receiver in the mounting fixture so that the flat bottom of the receiver rests squarely on the fixture's 90° mounting plate. The barrel is then elevated until centerline through the bore is parallel with the fixture and perpendicular to the fixture's hole locating pin or drill guide bushing. If the fixture and mill table are both level, barrel elevation can be checked with a .700" diameter mandrel (on the receiver bolt guideways) and a machinist's level.

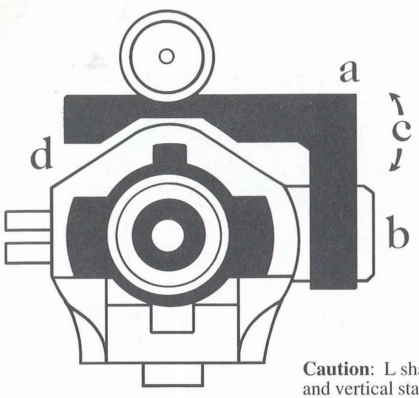
3. Use extra caution to prevent error when drilling sight screw mounting holes. Screw holes must not be drilled too deep or into the chamber or bore. Holes should not be drilled deeper than needed to tap four or five 6-48 threads. Set drill press or mill quill stop to limit drilling depth. Drilling even a few threads deeper is unnecessary and, depending on barrel thickness, can weaken the barrel. See fig. 156.

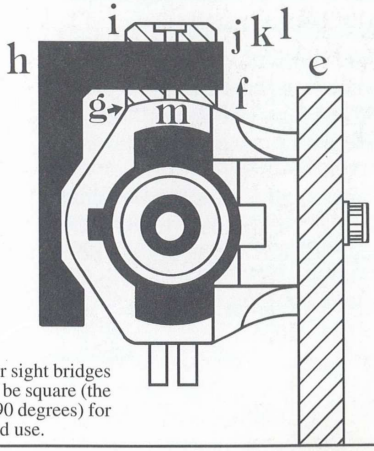
4. When mounting sights, always drill and tap one hole first. Cut threads with a plug tap followed by a bottom tap. Use a quality thread cutting oil and extra care to prevent stressing or breaking the tap. Stop and back out the tap if it catches or begins to feel springy. Then, deburr threads, detail clean, and temporarily install the sight. The sight mounting screw should be adjusted to correct length and snugged lightly. Check sight position. If an error has been made, this is your chance to correct it.

5. With correct sight position confirmed, install a drill bit that just fits inside the remaining mounting screw hole in the sight body. This drill is used only as a center locater. Center drill just deep enough to lightly dimple the barrel.

6. Remove the sight. Then, drill and tap for the second mounting screw. Remember to reset the drill press or mill quill stop to prevent drilling too deeply.

7. Adjust the second mounting screw to correct length, deburr and clean threads, install the sight, tighten the screws and recheck sight fit.





Caution: L shaped receiver sight bridges and vertical standards must be square (the sides must meet at exactly 90 degrees) for correct sight installation and use.

Figure 155- Shows steps for installing currently made receiver mounted sights, and older, no longer manufactured sights, such as the Lyman 48M and Redfield 70 and 80M. Correct steps for drilling, tapping, and mounting receiver sights on M91~M98 actions are indicated above and listed below.

Make the following checks before drilling and tapping sight mounting holes:

A. The receiver sight bridge and vertical standard must be perfectly square. If slightly bent, remove from sight and adjust until angle is exactly 90°.

B. Position the assembled sight and mounting base on the right side of the receiver bridge. When in desired position, make sure that the bolt handle will miss the sight.

C. Roll the sight assembly until the sight bridge is parallel with the flat bottom of the receiver. At this point, mounting base contour must match the contour of the right side of the receiver. If slightly different, adjust the base until it matches the side of the receiver when the sight bridge is parallel to the bottom of the receiver.

Caution: If a receiver sight is incorrectly mounted, or mounted on a warped or tweaked receiver, the sight bridge will be tipped or rotated to some degree. In this event, a change in windage adjustment will automatically change elevation.

D. Make sure that the underside of the sight bridge clears the top of the receiver when the sight is in the required minimum elevation position. This is prechecked with the ramp and front sight positioned on the barrel.

Install receiver sight:

E. Install receiver on 90° drilling fixture, as shown above, and tighten the .250"-22 receiver mounting screws. Then, install the fixture in a mill or drill press vise, making sure that the receiver is level.

F. Apply Dykem Blue to the side of receiver where the sight is to be mounted.

G. Apply a thin coating of silicone sealant on the receiver side of the sight mounting base and preposition the sight assembly (less eye piece) on the receiver.

H. Adjust the sight bridge (which is now vertical) until it is exactly 90° to the table and mark sight base position.

I. Locate the first sight mounting hole position and center mark. Then, remove the sight and drill and tap the first mounting hole in the receiver.

J. Then, clean the sealant from the sight and receiver, temporarily install the sight, snug the mounting screw, and recheck sight position.

K. With correct sight position confirmed, remove the sight bridge and install a drill bit that just fits inside the remaining mounting screw hole. This drill is used as a center locater. Center drill just deep enough to lightly dimple the receiver.

L. Remove the sight base and drill and tap for the second sight mounting screw.

M. Adjust mounting screw length until both are just flush with the inside surface of the bolt guideway in the receiver. Then, deburr and polish guideways with #400 sandcloth, Use the receiver lug way polisher shown in figure 201.

Barrel Muzzle O.D. and Front Sight Ramp Installation

Lightweight profile, 2 3/4 to 3 pound custom sporter barrels are popular with hunters and are probably the style most often installed in Mauser actions by riflesmiths. Most lightweight sporter barrels have muzzle diameters in the .600" to .625" O.D. range. These barrels should not be drilled and tapped for screw-on type front sight ramps. See safety warning in figure 156.

Rifle manufacturers preserve barrel wall thickness in thin barrels of this type by end milling, rather than drilling, sight ramp mounting holes to a shallow 2 1/2 thread 6-48 thread depth. Because it's difficult to tap only 2 1/2 threads, I would suggest sweating sight ramps on thin walled barrels, instead.

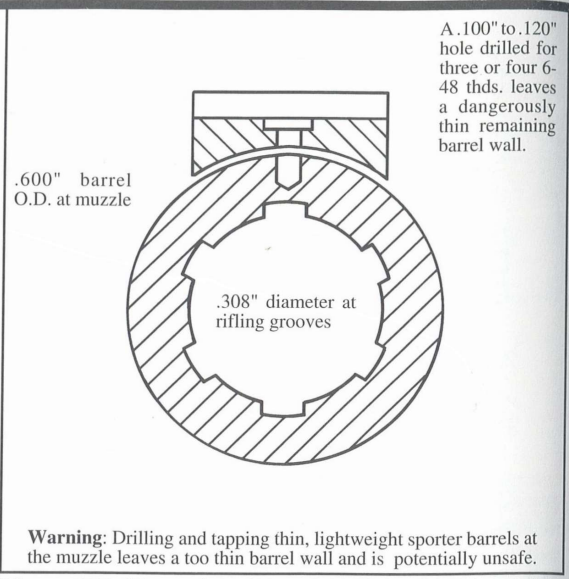
About Soldering Sight Ramps

Front sight ramps should be soldered on for cosmetic reasons or when barrel O.D. makes drilling and tapping a questionable or potentially unsafe procedure.

The lowest temperature solder should be used. Use a 50-50 lead and tin alloy (flow temperature 420°F) for sweating on front sight ramps when rifles are to be rust blued. A solder/flux paste works well in this application. An anti-flux inhibitor will help prevent solder from tinning and running where it is not wanted.

Lead based solders are not recommended for use in hot oxide bluing tanks due to the aggressive action of the salts and potential for contamination of the oxide bluing salt bath. Hi-Force 44 solder (flow temperature 475°F) is 96% tin and 4% silver and appears, thus far, to be inert in most oxide bluing baths.

I don't recommend silver soldering or brazing sights or sight ramps on rifle barrels. High, uneven heat can warp, stress, and otherwise damage the barrel. Alloy steel barrels that have been quenched or cooled rapidly after silver soldering can become embrittled and weakened.



Warning: Drilling and tapping thin, lightweight sporter barrels at the muzzle leaves a too thin barrel wall and is potentially unsafe.

Figure 156- Illustration shows the effect of drilling a light sporter barrel for installation of a screw-on front sight ramp. Muzzle O.D. of many lighter barrels is about .600". Wall thickness in a .30 caliber barrel would be .146" presuming a .308" groove depth. Tapping 3 or 4 full 6-48 threads would require a drill depth of about .100" to .120", leaving an unacceptably thin barrel wall of only .026"-.046".

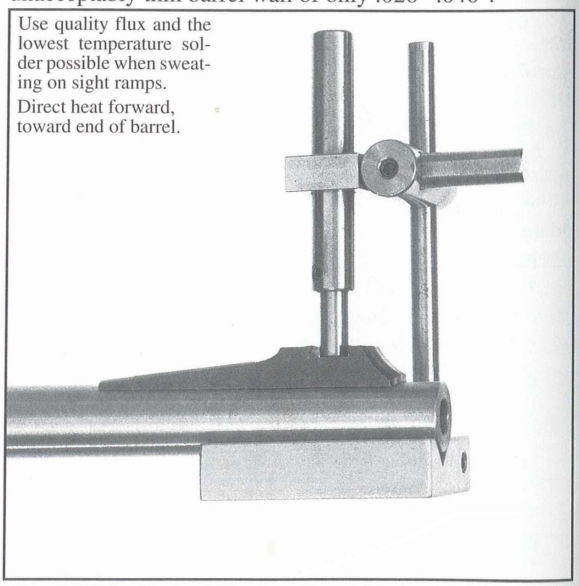


Figure 157- Shows a **Brownells** spring loaded sight ramp soldering fixture. The spring loaded sight ramp retaining plunger and vee block base permit easy barrel rotation to position the sight ramp at exactly top dead center. The spring loaded plunger then holds the ramp in position during soldering. The fixture's aluminum base tends to equalize heat and helps solder flow evenly.

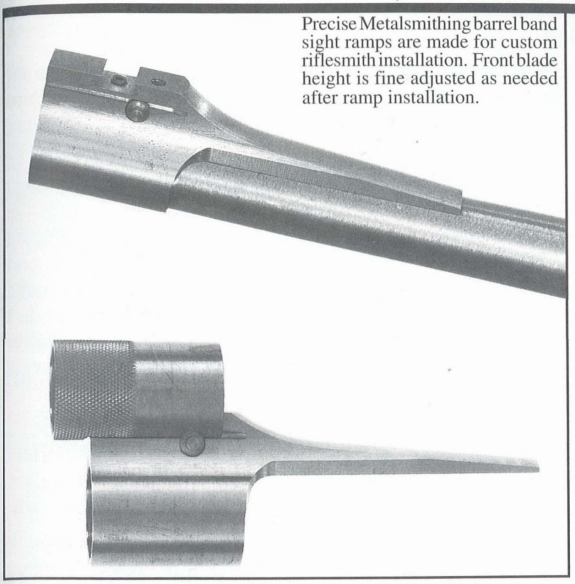


Figure 158- Shows views of Precise Metalsmithing Enterprises custom barrel band sight ramps, available in fifteen sizes from .500" to .945". These beautifully made sight ramps are also available with European dovetail cuts, and with and without hood and dovetail cuts. Other band diameters and ramp heights are available on a special order basis.

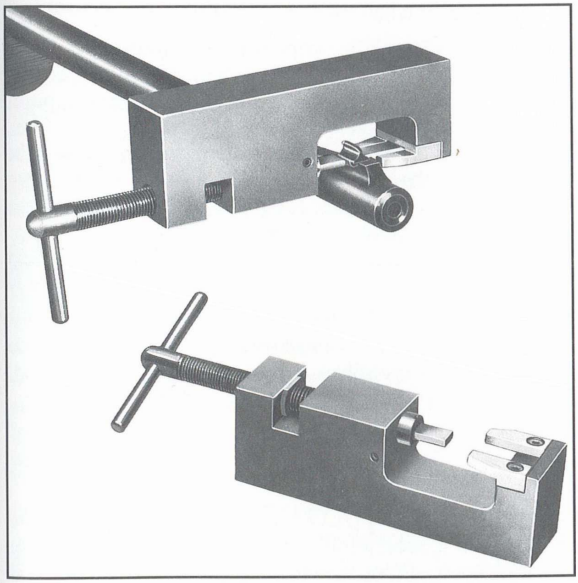


Figure 159- Shows a **Williams Front Sight Pusher,** at top, being used to install a 3/8" dovetail front sight blade. The sight pusher is shown separately, below. This excellent professional tool installs and adjusts side dovetailed front sight blades. Evenly distributed tool pressure on the sight ramp and sight eliminates drift/hammer dents, marks, etc.

Classic Style Rifle Sights

Classic style barrel band sight ramps, as shown in figure 158, are easily contoured and adjusted to fit barrel taper by honing and lapping the band and ramp extension on a tapered mandrel. Mandrel taper must agree with barrel taper.

Hone higher on the taper to increase barrel band opening diameter and ramp radius. When barrel fit is correct, the band and outside edges of the ramp extension should contact the barrel with a hairline fit. Most band/ramps of this type can be secured to barrels by installing and tightening a set screw under the sight dovetail. If the band and ramp are to be sweated onto the barrel, radius clearance the center underside of the ramp extension a few thousandths to improve solder flow.

Install Dovetail Front Sight Blade

1. Deburr and clearance the sight and sight ramp dovetails. Then trial fit the sight blade in the ramp. The sight dovetail should just start into the ramp dovetail by hand. Do not overclearance- the front sight blade must not loosen once installed.
2. Use a sight installing tool with aluminum jaws, as shown in figure 159, to prevent sight blade, ramp, and metal finish damage,
3. If the rear sight is adjustable for windage, push the front sight blade in until centered in the ramp.
4. If the rear sight is not windage adjustable, push the front sight dovetail in part way. Bore sight, test fire and fine adjust front sight position in the ramp to center the bullet on the target.

Caution: adjust sight blades carefully. Pushing the front sight blade too far and then moving it back will loosen dovetail fit.

If the barrel and front sight ramp are to be oxide blued, blue the barrel and ramp and install the sight blade afterwards to prevent salts entrapment and possible salts bleedout damage. Sight blades can be installed before bluing when a bleedout neutralizer solution is used.

About Rifle Scopes and Scope Selection

For best results, rifle scopes should be selected for a specific use; i.e., short range brush hunting; medium range hunting in mixed terrain; medium to long range hunting in open country; medium to long range varmint shooting, target shooting, etc. When selecting a scope, the following important factors should be considered:

1. Field of view vs. magnification- field of view decreases as scope power increases. For this reason, lower power scopes are desirable for short range brush hunting and hunting in broken terrain where the largest possible field of view is needed. Higher magnification scopes are desirable on medium and long range hunting rifles. Magnification increases apparent size of the target and permits a clearer view of the target kill zone. Target size must appear large enough to make reasonable hold over and hold under estimates. Varmint shooting typically requires even higher scope magnification than needed for medium and big game hunting. At 200 to 300 yards, smaller objects require sufficient magnification to accurately position the sight reticule on target. Target shooting also requires higher magnification.

Higher power scopes (magnification of greater than 10 power) are better used on target/varmint rifles fired from a rest or bipod. With high magnification, a rest is a practical necessity. The effect of rifle/scope movement is multiplied by the magnifying power of the scope. At 12X and higher, even the slightest movement can take the scope completely off a small target at 200 to 300 yards.

2. Variable power- variable power scopes are primarily intended for rifles that would be used in a variety of hunting conditions. Ideally, magnification would be adjusted lower in brush or broken terrain, and higher in open country when range to target was greater. A shortcoming with some cheap variable power scopes is that exit pupil diameter is large enough to be useful at low magnification but too small when the scope is adjusted to higher magnification. A small exit pupil can produce an incomplete image or a blurred image with darkness surrounding it. This would occur, at a higher power setting, when the rifle stock was cheeked as it would be when the scope was set at a lower power. The tendency, in this case, is to change cheek position or to crowd the scope to get a better picture. Changing cheek position wastes targeting time. Crowding the scope reduces eye relief and increases risk of eyebrow injury when the rifle is fired.

3. Exit pupil- is the name given to the cone of light that a rifle scope transmits to the eye. This, naturally, is based on normal eye relief position. Exit pupil diameter decreases, in variable scopes, as the power setting is increased. When selecting a variable power scope, find out what the exit pupil diameter is with the scope adjusted to maximum power. To get by in low light hunting conditions, the exit pupil shouldn't be smaller than about 4.8mm (about .189"). However, in an ideal low light scope, the exit pupil diameter would be at least 5mm (about .197") to match or exceed human eye pupil opening diameter in low light hunting conditions. See figure 160. In a low light/high power setting condition, a minimum exit pupil of about 5mm would make cheeking the stock forward to get a full picture virtually unnecessary. Brighter light automatically reduces eye pupil size and allows a certain amount of forgiveness for scopes with small exit pupils. With this in mind, always check variable scopes in low light, at max. power, and at standard 2" to 2 1/2" eye relief.

4. Reticule style- this is purely a matter of choice. However, fine crosshair reticules can blend into the field background and virtually disappear in low light conditions. Large posts, on the other hand, can obscure small targets and cover too much of the field at higher magnifications.

5. Occular focus- the range of focus in any scope should be sufficient for most individuals to focus the scope without having to wear glasses. With variable power scopes, one focus setting should be able to handle the full range of power adjustment.

6. Objective focus and parallax- adjustable objective focus (A.O. type) scopes can be desirable on some medium and long range rifles. In A.O. type scopes, parallax error is reduced by adjusting objective lens focus to agree with estimated distance to target. Even when adjustment is based on a range estimate that is off by 20%, parallax error would still be reduced by 80%. See figure 161.

7. Lens coatings- anti-reflective lens coatings increase light transmission by reducing reflection and light absorption. Fully coated lenses can provide 8 to 10% more useable light. Low light visibility is improved in scopes with coated lenses.

8. Correct mounting- no matter how good the scope, it can be no better than its mounting system. Always use quality mounts.

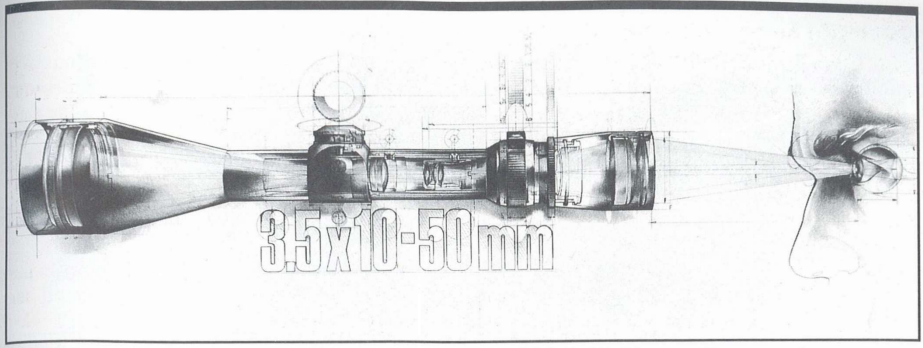


Figure 160- Excellent phantom illustration of a **Leupold 3.5x10-50mm** rifle scope demonstrates the effect of large (and fully useable) objective lens diameter on exit pupil size in a superbly designed scope- illustration, courtesy **Leupold & Stevens, Inc.**

A scope's exit pupil size (the diameter of the cone of light transmitted to the eye based on normal 2" to 2 1/2" eye relief), can be estimated by dividing the unrestricted, useable objective lens diameter by the magnification power of the scope. The important words here are *unrestricted* and *useable.* In the Leupold scope, shown above, unrestricted objective lens diameter is actually 50mm. So, 50mm divided by 10x equals a 5mm exit pupil at highest magnification. Other scopes with as large, or larger, objective lenses that are partially restricted by lens mounting or scope tube design, can actually have a smaller exit pupil. For example: a 50mm lens with an effective 4mm restriction would have a disappointing 8% smaller or 4.6mm diameter exit pupil.

The exit pupil diameter delivered by any scope used in full daylight would almost always be larger than the eye's pupil opening in daylight. The excess exit pupil diameter would be unused and go unnoticed.

In all scopes, exit pupil diameter decreases with magnification. In variable power scopes, only the exit pupil size delivered at maximum magnification is important.

In typical low light hunting conditions, human eye pupil opening size averages approx. 5mm. A rifle scope with legitimate low light capability must be able to deliver, at maximum magnification, an exit pupil diameter at least as large as the pupil opening of the human eye under low light conditions. A quality low light scope must also deliver acceptable image definition and contrast in low light.

Some scopes transmit light more efficiently than others. Light transmission efficiency is extremely important and makes a critical difference in low light scopes. Some scopes lose up to 10% of the light received due to reflection back through the objective lens and/or light absorption and loss inside the scope, itself. Well engineered scopes with individually coated lenses minimize light transmission loss.

After deciding on fixed or variable magnification, desired power range, reticule style, and the scope body size needed for correct mounting and eye relief, go the rest of the way on points. I would suggest making your final selection based on manufacturer's name and reputation, length of manufacturer's warranty, and the scope having the following features:

1. A large, unrestricted objective lens
2. An exit pupil size of at least 5mm at maximum power (in low light scopes)
3. A well engineered design, including individually coated lenses
4. The widest possible field of view at maximum power
5. High overall quality of optics and scope construction

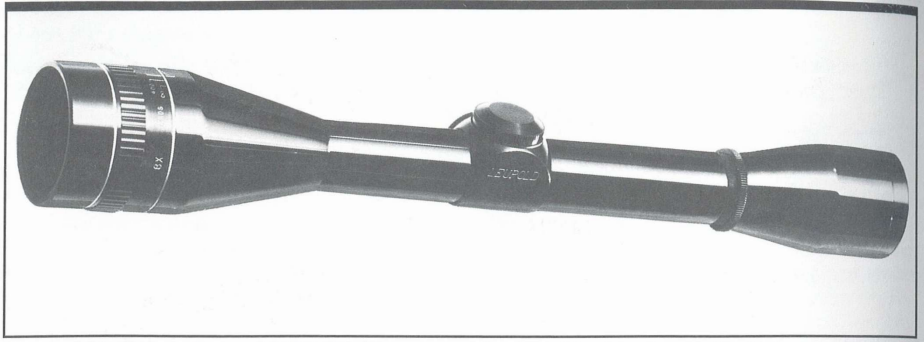


Figure 161- Shows a **Leupold M8-8X** rifle scope with adjustable objective (AO). Estimating yardage to a target and making the corresponding objective focus adjustment can reduce parallax error at any given distance. Parallax can cause sighting errors of up to 1" at 300 yards in rifle scopes with quality optics. Parallax is caused by lens curvature and creates a small difference in sight line versus target position. The net effect of parallax error is the same as if the target had shifted position slightly. The above error factor of 1" in 300 yards would not be a problem in medium and big game hunting. In this case, a rifle scope with an adjustable objective would not be of particular use. However, a 1" error would be critical when a target is small and range to the target is long; varmint shooting would be a good example of this. Rifle scopes with adjustable objectives can offer extra flexibility to hunters using .22 centerfire and 6mm sporting rifles. Because parallax error increases with distance, parallax error correction is necessary for accurate long range target shooting.

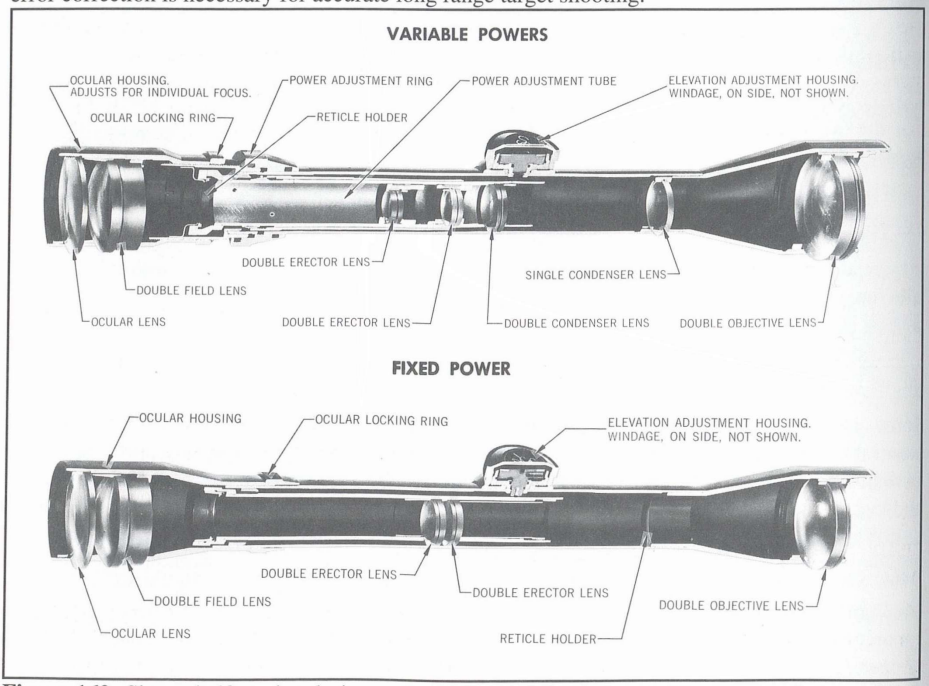


Figure 162- Shows half-sectional views of variable and fixed power rifle scopes- photo courtesy **Williams Gunsight Co**. In modern rifle scopes, the reticule holder is located near the subjective end of the scope. Crosshairs are not adjustable. Windage and elevation adjustments are actually made by moving the position of the erector lens tube with the external adjusting screws. In variable power rifle scopes, movement of the internal power adjusting tube increases or decreases magnification. In both fixed and adjustable power scopes, the occular housing (subjective end) is moved as needed to adjust focus. Scope tubes are filled with dry nitrogen to prevent fogging and condensation on the inside.

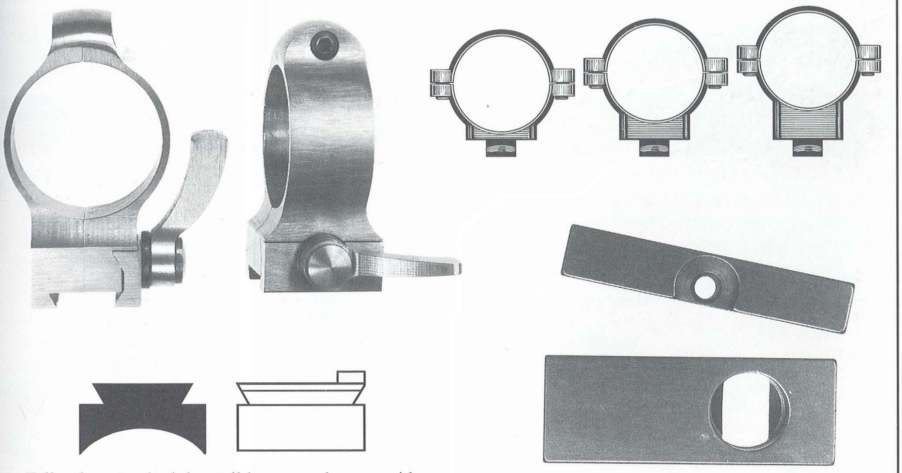


Figure 163- Shows Kimber/Brownell classic style scope mounting rings, at upper left, manufactured by Precise Metalsmithing Enterprises. These high quality mounting rings are manufactured with lever dovetail locks, as shown above. Kimber/Brownell rings are available in sizes to fit 3/4", 7/8", 1", and 30mm scope tubes. Dovetail mounting bases, see illustrations below, are available for Mauser small and large ring actions and several other actions at the time of writing. Dovetail bases can also be gunsmith made from 1020 steel when special height or mounting is required. This dovetail mounting system permits a wider than otherwise available range of ring mounting positions to accommodate longer and shorter scope bodies. The standing recoil lug, shown in illustration, prevents scope and ring movement on scope base dovetails.

Leupold standard scope mounting rings, illustrated at upper left, are available in high, medium, and low heights. Unfinished, oversize Leupold Gunmaker mounting bases, shown just below, are drilled and contoured by the gunsmith to fit the individual receiver.
A well made, correctly fit and installed scope ring and base mounting system is as important as the scope, itself. Poor quality mounts and improper installation can stress or otherwise damage a scope body, limit the range of elevation and windage adjustment, or even make correct adjustments impossible. See pages 145 through 152 for fitting data.

Scope base, scope ring, and mounted scope body position must allow a 2" to 2 1/2" eye relief when the rifle is shouldered. Stock comb and mounted scope height must permit the exit pupil to center in the eye as the cheek comes to rest on the stock.

I suggest using an adjustable trial rifle to determine the individual customer's scope height and and eye relief position requirements rather than experimenting with various scopes, rings, and bases on a customer's rifle.

Plus and minus manufacturing variations in scope base, scope ring, receiver ring height, and receiver bridge height, combine with mounting errors (however slight), to stress, tweak, or bend scope tubes. This condition, in turn, stresses the receiver and, depending on severity, causes windage and elevation adjustment problems. Most plus and minus dimensional differences can be compensated for by adjusting scope base height.

Ideally, mechanical centerline through the body of an installed scope should be parallel with the centerline through the receiver and bore. Mounting systems must be perfectly aligned so that the scope and receiver are not stressed or the scope tweaked when tightly clamped in the mounting rings. See figure 164.

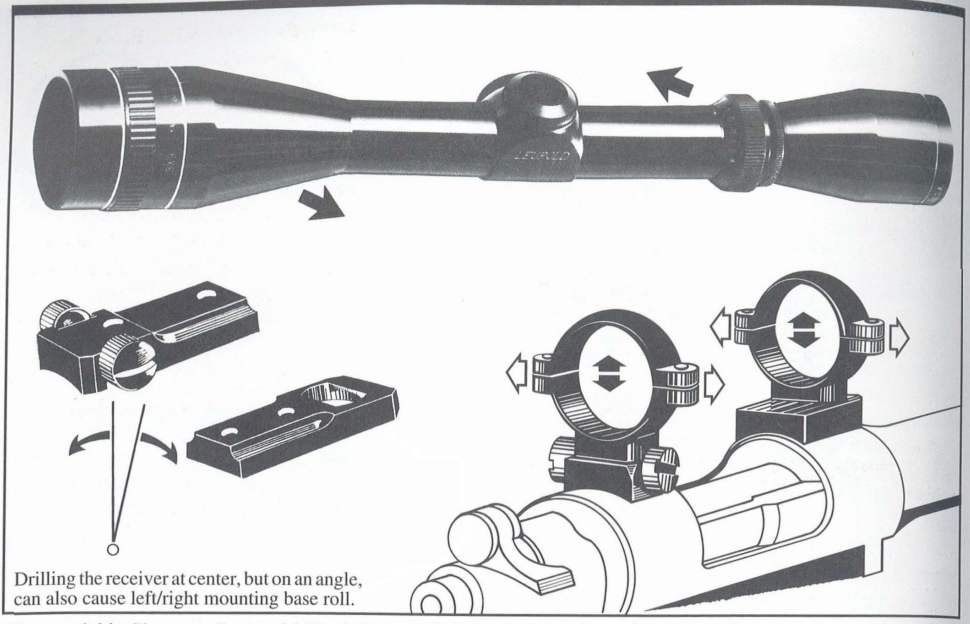


Figure 164- Shows a Leupold Vari-X II 3x9 Scope with adjustable objective, at top. Illustrations, below, show basic scope alignment problems caused by mismounted bases. Mismounting divides into two main categories: base/ring positions that are rolled right or left, and base/ring positions that are too high or low. Left-right rolls are caused by receivers and/or bases that are not drilled and tapped precisely at top dead center. Although manufacturing tolerances are additive and part of the problem, high or low base/ring position problems are caused by failure to adjust scope base heights in order to level scope ring saddles.

A third problem area includes otherwise correct base/ring installations that will not allow correct scope mounting relative to eye and cheek position. In this case, the scope is either too high or low or too far forward or back. Eye relief problems can be particularly evident when scopes with short tubes are installed on long and medium receivers. Although most standard mounting systems permit short scopes to be installed on almost any receiver, there is often not enough available tube length to position the scope for correct eye relief. Common installation problems are listed below:

A. The scope is rolled to the left or right-

1. The receiver and/or bases are not drilled at top dead center

B. The scope is angled to the left or right-

1. The receiver ring and/or front base are not drilled at top dead center
2. The receiver bridge and/or rear base are not drilled at top dead center
3. Possible miscut radius on the bottom of one or more bases

C. The scope is mounted high/low (not parallel with centerline through the receiver)

1. Receiver ring O.D. is not standard and the front mounting base was not adjusted
2. Receiver bridge height is not standard and the rear mounting base was not adjusted
3. Mounting rings are off tolerance and compensating adjustments were not made in base height

D. Other mounting problems-

1. The scope is too far back. Base/ring positions or a short scope body do not allow enough eye relief.
2. The scope is too far forward. Base/ring positions or a short scope body create excessive eye relief.
3. The scope is mounted correctly, but exit pupil is too high or low, caused by incorrect ring height or an incorrect base/ring combination.
4. The scope body is bent, indented, or stressed, caused by any combination of A, B, or C, above.
5. The top of the receiver is stressed, caused by any combination of A, B, or C, above.

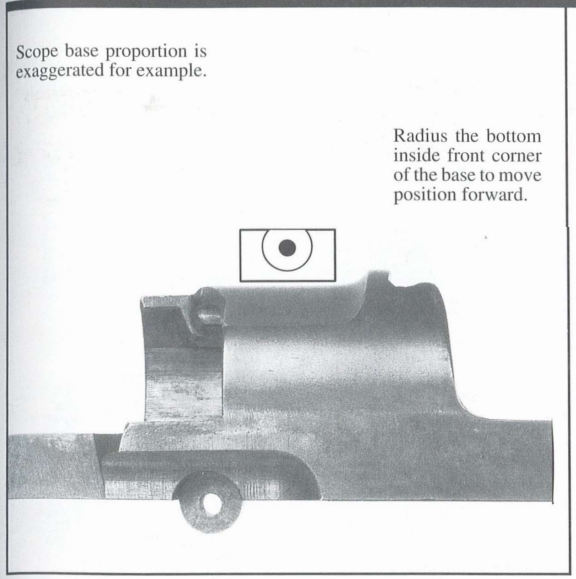


Figure 165- Illustration depicts a Leupold Gunmaker rear scope base as it would be positioned on an M98 military receiver. After shortening, the bottom of the base is radius cut and milled to agree with the top contour of an M98 receiver bridge. The base position shown permits the widest possible ring separation, useful when installing longer scopes.

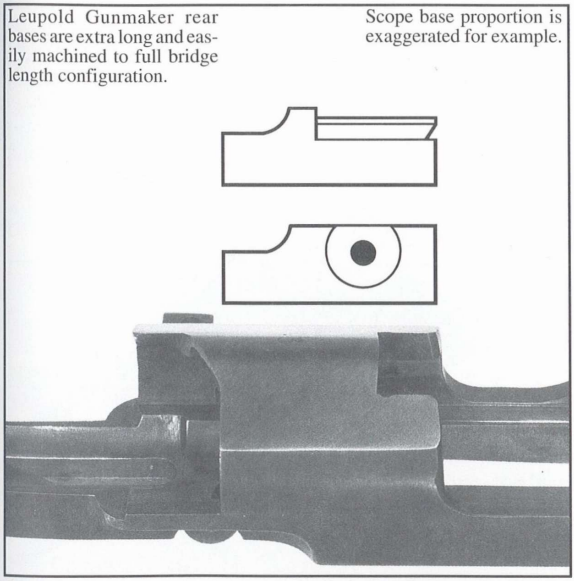


Figure 166- Shows an M98 receiver with magazine clip loading flange milled off for installation of a gunsmith made full bridge length rear scope mounting base. Custom made full length bases allow the gunsmith to select the rear scope ring position needed to mount a particular scope with correct eye relief. When ring position is established, the base can be lightened by milling off excess material.

Rear Base and Ring Positions

Most currently available mass produced scope mounting systems were designed for older, more easily positioned long tube scopes.

Many currently manufactured scopes have tube sections that are somewhat short for mounting on standard length Mauser actions with off the shelf two piece bases. Although some base and ring combinations will permit installation of scopes with short tubes on standard length Mauser actions, scope position may not be workable as far as correct eye relief is concerned.

Stock pull and comb height must fit the owner before scope installation. Rifle scopes should be mounted with the eye piece about 2 1/2" forward of the shooter's eye (and not closer than 2" to the eyebrow) with the rifle shouldered and comfortably cheeked.

Before building a custom rifle: Determine customer stock dimensions, scope exit pupil alignment, and correct eye relief position with an adjustable trial rifle.

Existing rifles: Have the customer shoulder and cheek the rifle. Determine scope exit pupil alignment and eye relief position by placing high, medium, or low wood spacers under the scope tube and trial positioning the scope. When correct position is determined, mark eyepiece position and scope tube extremities on rifle with a grease pencil. Then, select bases and rings and measure the receiver for base and ring installation.

Note: In some cases, the clip loading flange on a Mauser military receiver bridge will be in the way. Factory elimination of the loading slot and flange on FN M98 sporters permitted mounting scope bases further forward on the bridge. When mounting short tube scopes, it is sometimes helpful to mill off the flange and install a full length, gunsmith made base. In some cases, locating front scope ring position slightly to the rear to reduce the distance between the rings increases scope mounting flexibility.

Leupold Gunmaker bases are excellent for this purpose. See figures 165 and 166.

Remove Receiver Magazine Clip Loading Flange

The magazine clip loading flange on Mauser receivers can be removed when scope tube length and correct scope eye relief adjustment would make forward positioning of the rear scope base and ring necessary.

Gunsmith made rear scope bases must match the contour of the rear receiver bridge and be long enough and wide enough to fully cover the clip loading slot.

Remove loading flange as follows:

1. Prevent receiver misalignment on the milling fixture (see fig. 167) by detail cleaning the receiver and fixture to make sure that all chips and foreign material have been removed. Also clean mill vise and hold down clamps.
2. Place the flat receiver bottom on trued surface of milling fixture. If the bottom of the receiver does not fully contact the surface of the fixture, check for cause before installing hold downs. See receiver mandrel straightness check on page 68. Do not mill receivers that are bent or warped. If the receiver is straight, install hold downs and tighten.
3. If a milling fixture is not used, adjust the mill head to match the angle of the sloped rear bridge surfaces behind the clip flange.

Note: This angle typically measures about 30°, but can vary somewhat with individual receivers.

4. Install a 3/8" or 1/2" carbide end mill. Mill the loading flange in .010" passes until fractionally above flush with the bridge.
5. Then install a carbide tip face mill or a small fly cutter. Clean and true the full length of the flat surfaces.

Caution: When truing these surfaces, remove no more than a few thousandths from the bridge. See additional caution in figure 168.

6. Remove the remainder of the flange at the top of the bridge with a toolpost grinder, or contour by hand with a file to blend the area in with the existing bridge radius.
7. Remove machine marks as discussed in figure 168.

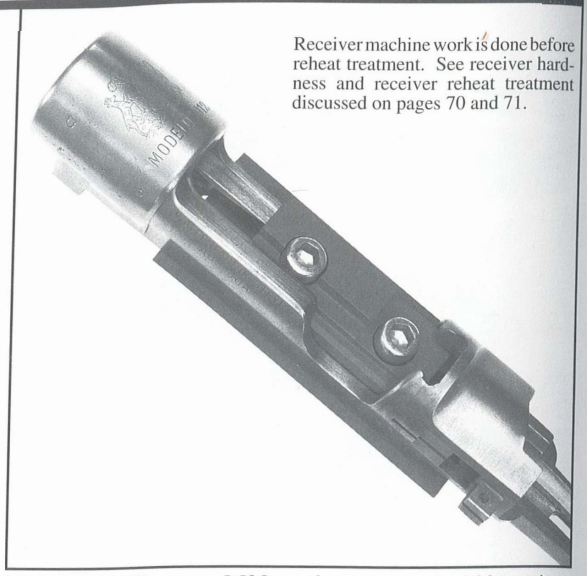


Figure 167- Shows an M98 receiver set up on a 30° receiver bridge milling fixture in preparation for milling off the rear bridge magazine clip loading flange. The flange is removed with a carbide end mill. The flat surfaces are then full length cleaned and trued with a fly cutter. An alternative, but slower, method involves adjusting the mill head to match the angle of the flat surfaces on either side of the bridge radius.

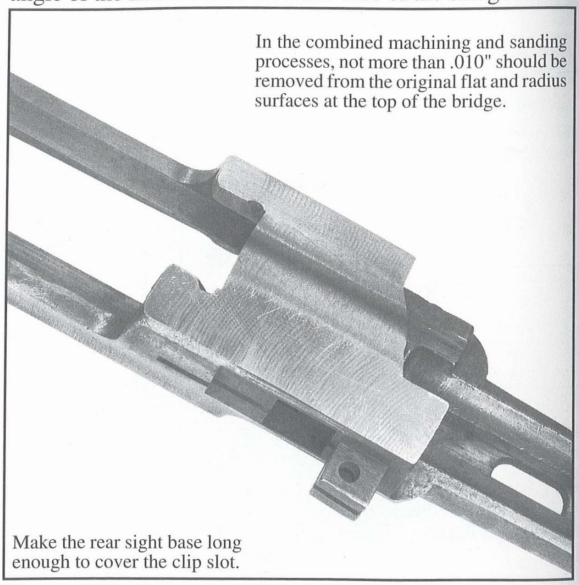
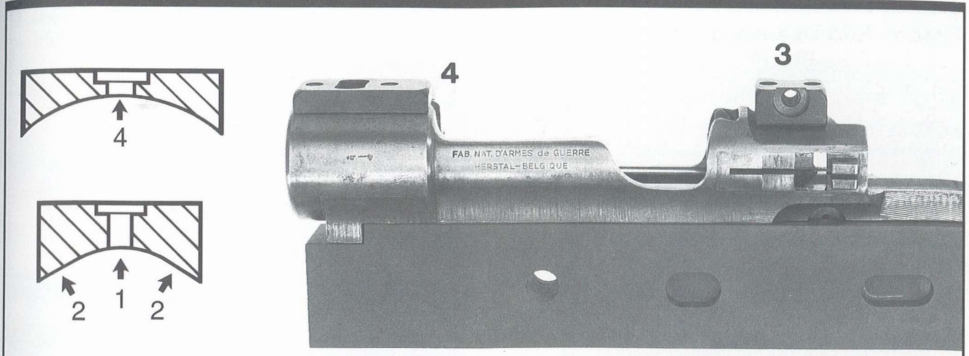
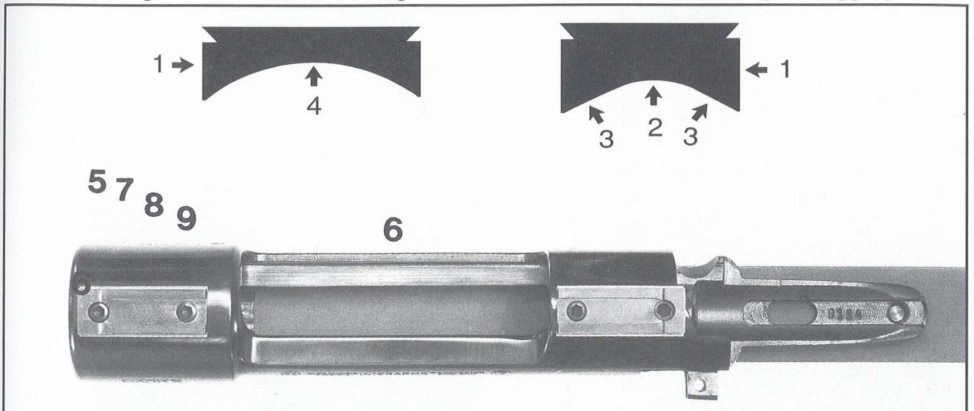


Figure 168- Shows an M98 receiver bridge after the clip loading flange has been milled off and trued with a fly cutter. The material left at the top of the flange has been shaped to match the original radius at the top of the bridge. This can be done with a toolpost grinder or by hand. Remove machine marks with #320 and #400 sandcloth on a trued steel sanding block. Keep sandcloth wet with solvent for faster cutting.



Scope base proportions are exaggerated for example

Figure 169- Shows bottom contour and height adjusting steps for Leupold Gunmaker scope mounting bases. When scope bases are thick enough, this method can be used to adjust other ***top surface critical*** mounting bases including most windage lock, rotary dovetail, and front pivot types. The center of the rear base, at **1**, is radius cut with a ball end mill to match receiver bridge radius. The bottom sides of the rear base, at **2**, are milled to agree with the flat surfaces on either side of the bridge radius. See page 148. The surfaces at **1** and **2** are then carefully hand finished until the base precisely fits bridge contour. Rear base height on the receiver bridge is then measured, at **3**. The front base, at **4**, is radius cut to match the receiver ring. On short to medium range rifles, depth of radius is adjusted until the front ring saddle indicates at the same height as the rear ring. (Also, see long range rifle scope base data on page 148). Scope bases are then adjusted to the desired length and drilled and counterbored for receiver mounting screws. See figures 173 and 174. See figures 175 and 176 for receiver drilling and tapping.



Scope base proportions are exaggerated for example

Figure 170- Shows fitting steps for blank dovetail scope ring base blocks. The sides of the blocks, at **1**, are cleaned and paralleled with a fly cutter. The center of the rear base, at **2**, is radius cut with a ball end mill to match bridge radius. The bottom sides of the rear base, at **3**, are milled to agree with the flat surfaces on either side of the bridge radius. Surfaces at **2** and **3** are then carefully hand finished to precisely fit receiver bridge contour. The front base blank, at **4**, is radius cut and hand fit to match the front receiver ring. See page 148. Bases are drilled and counterbored for mounting screws at **5**. See figures 173 and 174. The receiver is then drilled and tapped and bases installed, at **6**. See figure 175. The tops of the bases, at **7**, are milled to the desired height (recoil lug is optional). On short and medium range rifles, a line across the tops of both bases must be parallel with the centerline through the bore and receiver. See page 148 for long range rifle scope base data. The sides of the bases, at **8**, are checked for parallel and adjusted as necessary. Dovetail base blocks can rise above the receiver on a taper but must be square at the top so that dovetails can be machined into the blocks. Scope base dovetails are cut at **9**. Consult scope ring manufacturer's dovetail specifications, before milling.

Contour Rear Scope Base

1. Adjust the rear scope base blank to length, true the ends, and secure in milling fixture. See figure 171.
2. Mill the radius at the center of the rear base with a ball end mill.

Note: A 1 1/8" ball end mill has a .531" radius and can be modified to mill center base contours to match the radius found at the top of Mauser receiver bridges.

3. Mill the angled surfaces on the sides of the base to agree with the flat sides of the receiver bridge on either side of the radius. Typical surface angle is 30°. Actual angle, however, should be cut to match the receiver.
4. Hand finish the bottom of the rear base to a hairline receiver bridge fit.

Contour Front Scope Base

1. Cut the front scope base blank to length, true the ends, and clamp in mill fixture as shown in figure 172.
2. Measure the radius at the front ring. Cut the same radius in the bottom of the front scope base with a small boring bar used as a cylindrical facing cutter.
3. Fine adjust depth of cut for correct scope ring height. See depth adjustment discussed in figure 169. Make the final cut a few thousandths shallow to permit hand fitting the scope base to exact receiver ring fit.

Caution: Scope bases and receiver rings that have been ground, or that are otherwise slightly irregular, may require special fitting to level the top of the base on the receiver ring.

Bases for Long Range Rifles

To prevent running out of scope elevation adjustment, scope bases on 500-1000 yard rifles are usually milled on an elevation correcting angle. Correction angles of 1/8 or 1/4 of a degree are commonly used. A minute of angle is 1/60th of 1°, or 1.047" at 100 yards. The divergence angle produced by sloping the bases 1/8° would lower sight line by about 7.9" at 100 yards, 39.2" at 500 yards, and 78.3" at 1000 yds. Consult exterior ballistics tables for trajectory data before adjusting scope bases.

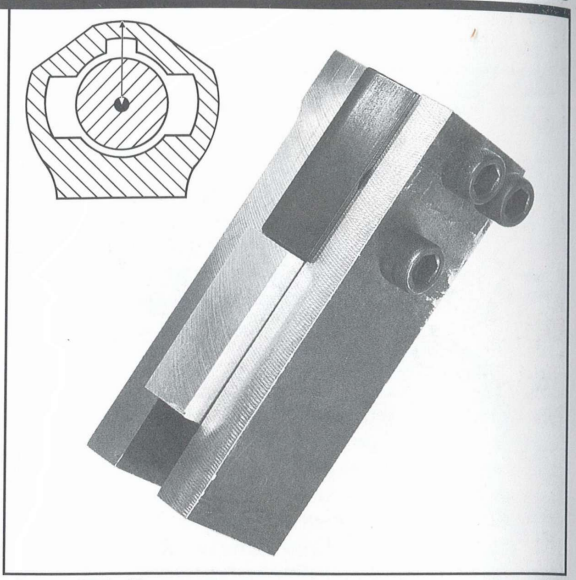


Figure 171- Shows a rear scope base blank secured in a mill fixture. The fixture is then clamped in a mill vise to radius cut the center of the base with a modified ball end mill. Side angles are cut from the same setup with a std. 3/8" end mill. Illustration at upper left shows finding bridge radius by placing a .700" diameter mandrel on the receiver bolt ways and measuring distance from center to bridge with dividers.

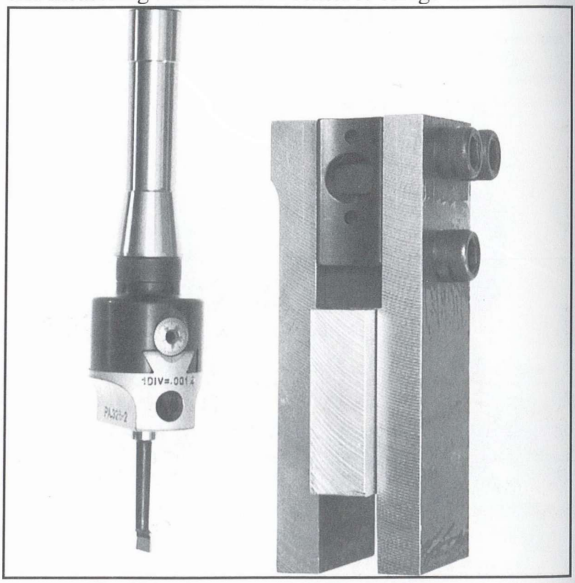


Figure 172- Shows a front scope base blank set up in the mill fixture, shown in fig. 171, to cut the bottom radius with a small boring bar. Boring bar and head are shown at left. Receiver ring radius can be checked in the mounting base installation area by placing a .700" dia. mandrel on the receiver's bolt ways and measuring the distance from the center of the mandrel to the top of the receiver ring.

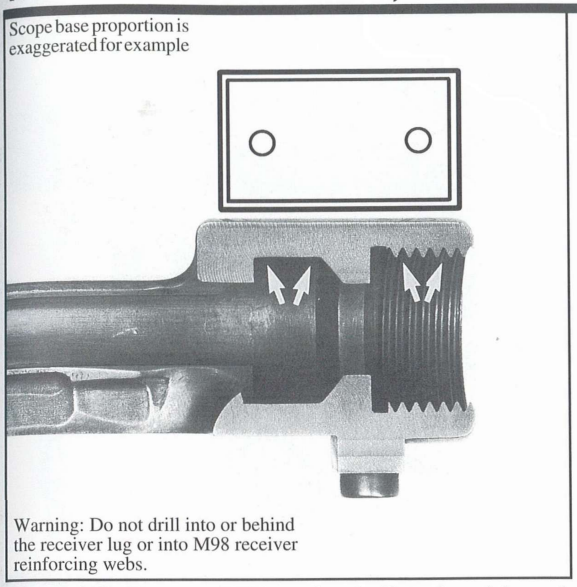


Figure 173- Shows an M98 receiver half sectioned through the front ring. Illustration of top view of the front scope base, above, shows a mounting screw hole layout that will permit drilling and tapping two 6-48 mounting screw holes inside the receiver's "safe drilling zones", indicated between arrows. **Warning**: Don't drill the receiver outside the safe zones.

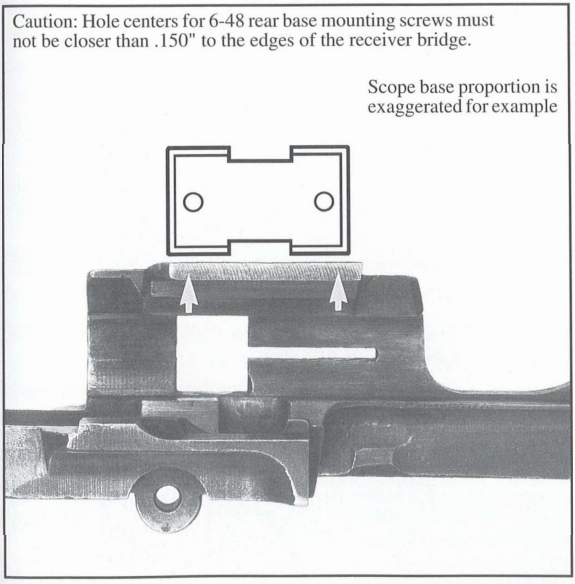


Figure 174- Shows an M98 receiver half sectioned through the rear bridge. Top view illustration of a short length rear base, above, shows a screw hole layout that will place the centers of two 6-48 rear base mounting screw holes at least .150" inside each end of the receiver bridge. The correct rear scope base "drill/tap zone" is shown between arrows, above.

Layout Scope Base Mounting Screw Hole Positions

Before drilling scope base mounting holes or drilling and tapping any receiver, always comparison check the proposed screw hole locations to be drilled in the scope bases against the receiver to make sure that mounting screw holes will be in the safe and correct receiver zones shown in figures 173 and 174. References given here are left/right. Receiver TDC hole positions are discussed in figures 175 and 176.

Layout Mounting Screw Holes in Front Scope Base

1. Coat top of receiver and front scope base with Dykem Blue.
2. Position the front scope base as needed to locate the front scope ring in the desired position. Mark base position on receiver for reference.
3. Mark proposed mounting screw hole locations on base.
4. Transfer the proposed screw hole center locations to the receiver ring.
5. Measure to make sure that the proposed hole locations are inside the receiver's "safe drill zone".
6. If O.K., scribe precise mounting screw hole locations on front base.
7. Precision center punch the base where left/right hole location lines intersect centerline through the base.
8. Drill and counterbore the base for 6-48 mounting screws.
9. Drill and tap receivers at TDC as discussed on pages 150 and 151.

Layout Mounting Screw Holes in Rear Scope Base

Depending on scope tube length, rear scope ring position may require a short length base or a full length base. See figures 165, 166, and 172. The steps for locating rear scope base mounting screw holes are basically the same as for the front base, except that mounting screw holes must not be too close to the edges of the receiver bridge. Milling off the magazine clip loading flange will permit locating the front mounting screw approx. 1/8" forward.

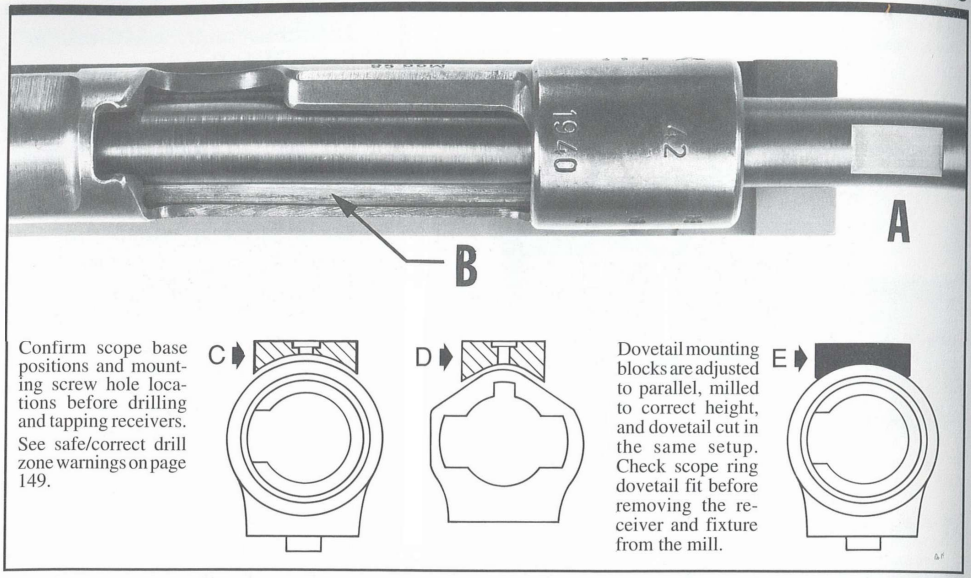


Figure 175- Shows an M98 receiver, at top, set up for locating, drilling, and tapping sight base mounting screw holes at top dead center on a mill. The receiver is secured to the mill drilling fixture, above, with .250"-22 Allen screws installed and snugged in the receiver's stock mounting screw holes. The threaded .700" diameter centering mandrel, at **A**, is installed and tightened in the receiver. The mandrel should slide through the bolt opening in the receiver reinforcing web with minimum clearance for correct centering. Mandrel clearance at the rear receiver bridge should be approximately the same at both sides. Set up receiver, mandrel, and fixture in the mill as follows:

1. Level and clamp fixture, shown above, in a 6", or larger, mill vise on mill table.

2. Check receiver alignment by indicating the sides of the mandrel at both ends. Adjust the mill vise as necessary until both ends of the mandrel indicate.

3. When the receiver is perfectly aligned, the mandrel is used to find centerline of the receiver by installing a locator tip in a collet and finding one side of the mandrel. At this point, the mill feed counter dial is set at zero. The diameter of the receiver mandrel is then measured with a micrometer and divided by two to find the center of the receiver. For example: a mandrel diameter of .700" divided by two would be .350". Advancing the mill table .350" would then center the receiver. **Note**: Due to grinding, polishing, and slight ovalling, the sides of Mauser receivers (and particularly the front rings) are often nonconcentric, and should not be used as a reference to find center.

4. Remove the mandrel from the receiver once centerline has been found. A supplemental receiver hold down clamp is installed across the magazine rails, at **B**, at this time.

5. Front and rear scope mounting bases, illustrated at **C**, **D**, and **E**, above, are rechecked on the receiver and the scope base mounting screw hole locations are confirmed.

6. When screw hole locations are confirmed, install a center drill and center dimple the receiver at the location of the first mounting screw hole for each scope mounting base.

7. Then, drill one hole per base with a #31 drill, install tapping tool and tap 6-48 threads the full depth of the hole. See safe and correct drill zone warnings in figures 173 and 174.

8. Clean and deburr the threads, install front and rear bases, and tighten screws. The tightened scope bases should be at the exact center of the receiver at this time.

9. Then install a drill bit that just fits inside the clearance holes in the bases for the two remaining 6-48 screws. Drill just deep enough to center dimple the receiver. Then, remove the bases and drill and tap the two remaining mounting screw holes.

10. Install the dovetail scope base blocks, at **E**, check for parallel, and mill to the desired height. Mill scope ring dovetails and check scope ring fit while the receiver is in the original setup.

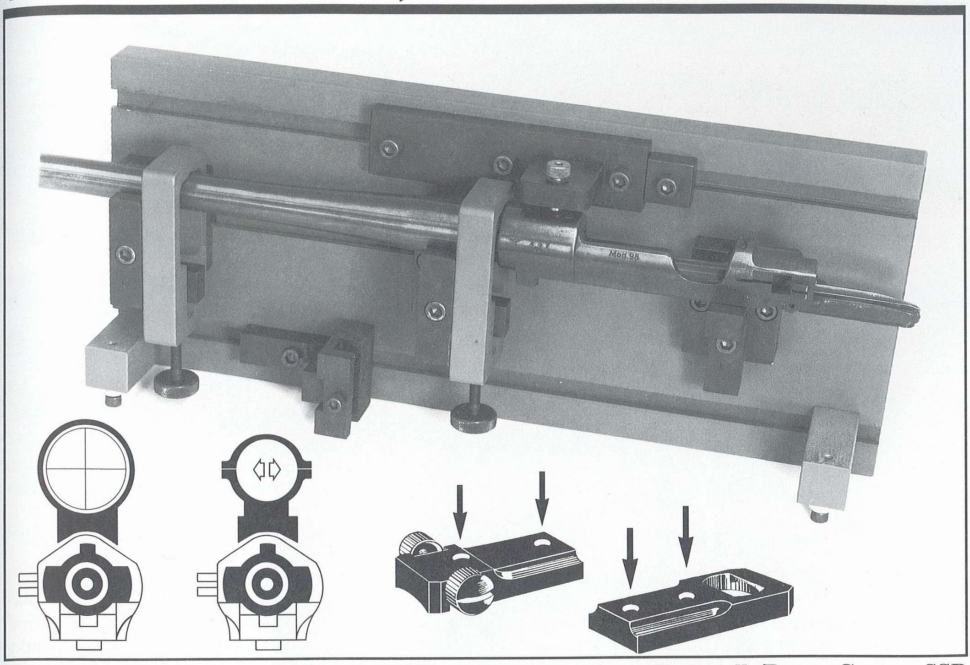


Figure 176- Shows a barrelled Mauser M98 receiver mounted on a **Brownells/Power Custom SSR Mounting Fixture** for drilling and tapping of scope mounting bases. This excellent fixture sets up quickly, mounts on a mill or drill press table, and is easily used by the riflesmith.

Vee shaped elevators center the barrel and receiver on the fixure. An L shaped receiver elevator/support bracket squares the receiver and prevents rotation when the yoke clamps are tightened. Barrel/receiver position is adjusted until the centerline through the bore and receiver is parallel with the fixture. An additional reference is needed in order to do this. The simplest approach is to position a trued .700" diameter X 8" long mandrel on the receiver's round bolt ways. The mandrel is pushed forward until it stops against the rear barrel face and then clamped to the round bolt ways. Barrel/receiver elevation on the fixture is then adjusted until the top of the mandrel indicates at two points that are at least 6" apart. A small machinist level can be used on the mandrel, instead of the dial indicator, provided that the fixture and mill or drill press table are also level. In this way, scope base mounting holes will be drilled at 90° to centerline in both planes.

Important Cautions:

Do not attempt to drill and tap a receiver that is warped or bent. See receiver mandrel check on page 68. Make sure that the bottom of the receiver is clean and square at the point where the receiver elevator/support bracket makes contact.

Do not attempt to drill and tap a receiver that has a bent or nonconcentric barrel. A barrel in this condition will cause misalignment of the receiver on the fixture.

Make sure the fixture is square with the mill or drill press table. This is easily done by clamping the fixture in a mill vise or by bolting the fixture to 90° hold down brackets.

Before drilling, recheck scope base fit on the receiver and make sure that the proposed mounting screw hole locations are in the safe/correct zones shown in figures 173 and 174.

Use caution when drilling: do not drill into the barrel threads. Preset the mill or drill press quill stop to prevent this problem.

Note: The gunsmith made dovetail ring base mounting blocks, discussed in figure 175, require height and parallel adjustment and dovetail cutting after the blocks have been installed on a receiver. For this reason, I suggest installing custom made dovetail bases using the mill setup discussed in figure 175.

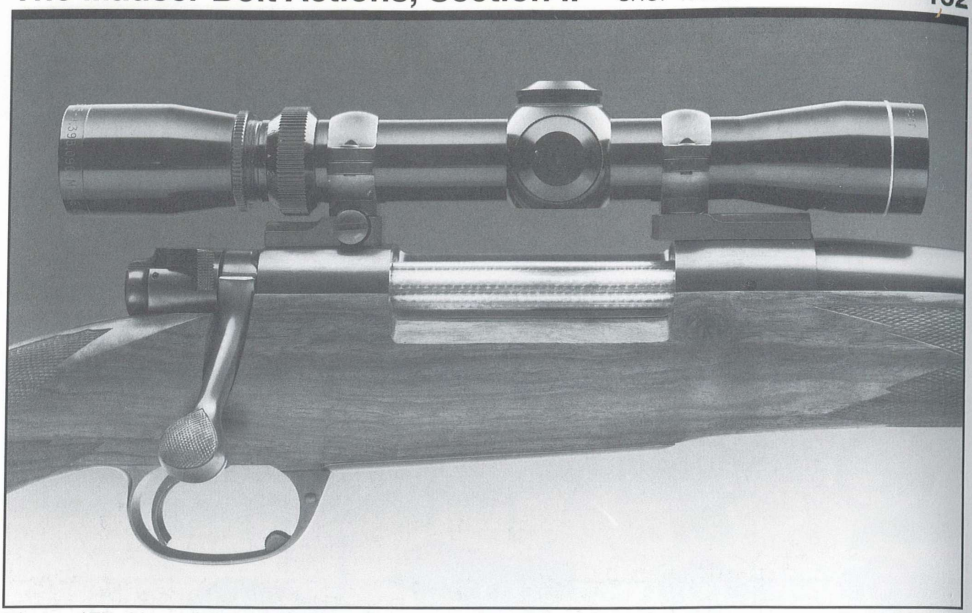


Figure 177- Shows a bolt action sporting rifle with a Leupold 2x7 Compact scope installed, ring and mounting screws tightened, and ready for bore sighting and test firing. To save ammunition and make final sighting in faster and easier, both scoped rifles and rifles with mechanical sights should be bore sighted before test firing. A basic bore sighting target similar to the illustration in figure 133 is helpful.

1. Remove the bolt and make sure the rifle magazine and chamber are not loaded. If the safety is on and the bolt is locked, point the rifle in a safe direction before moving the safety lever.

2. Position the rifle in a rifle vise on an even bench top surface and secure.

3. Place a bore sighting card on a target stand at a measured 100 yards. The black circle on the sighting card should be large enough so that, at 100 yards, it will appear to nearly fill the bore.

4. Align the rifle bore with the black circle on the bore sighting card. While viewing through the bore from about 12" behind the receiver, carefully adjust rifle vise position until the barrel chamber and muzzle opening form concentric circles that appear to surround the target.

5. Hold rifle and vise position while adjusting windage until the scope's reticule appears to be superimposed on the vertical centerline through the black circle on the bore sighting card.

6. Then, adjust scope elevation to position the sight reticule as closely as possible to the horizontal center of the target. This adjustment is a beginning reference, only.

7. Consult exterior ballistics tables for bullet drop data. Then, fine adjust scope elevation until sight reticule position is below the apparent center of the target by the approx. estimated amount that the bullet would drop in 100 yards. Bullet drop estimates are easily made by referencing the diameter of the target circle on the bore sighting card. For example, half of a known 8" diameter target would equal 4 inches and half of that 2 inches, etc.

When carefully done, these steps will adjust a rifle scope to approximate zero at 100 yards.

8. With bore sighting complete, remove the rifle from the vise and test fire from a sand bag and bench rest. Actual zero for a specific rifle/cartridge combination is determined by firing and sighting in from a bench rest.

Caution: Before test firing, make sure that the barrel and chamber are clean and dry, that the cartridge to be fired is correct for the chamber and barrel, and that action and safety mechanisms are in serviceable condition. See cautions on pages 97, 98, and 109, before test firing.

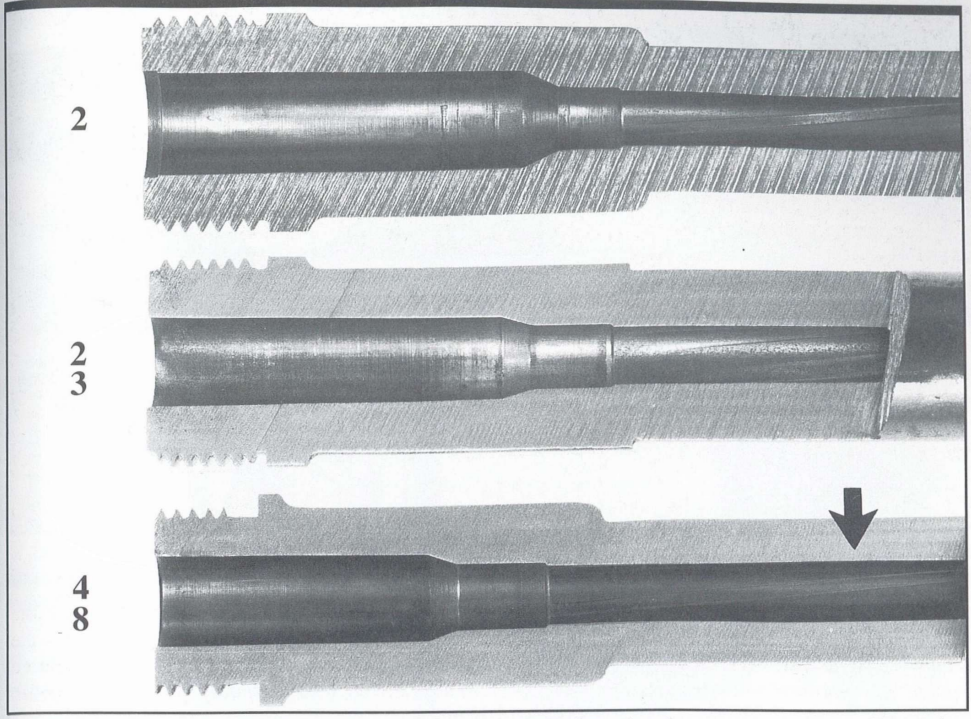
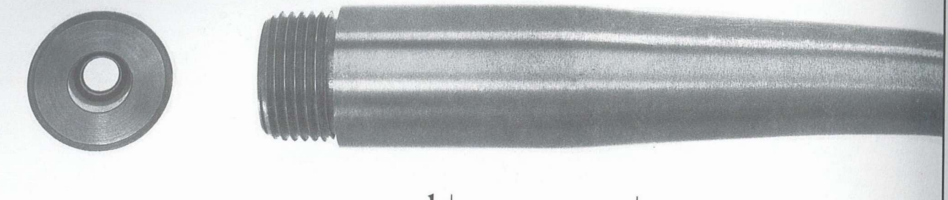


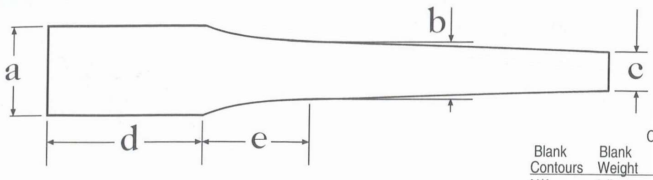
Figure 178- Shows several additional conditions that make barrel replacement necessary. Examples of other unserviceable barrels are shown and discussed on pages 87 and 112. Problem areas above are indexed to the list below.

Why Rifle Barrels Are Replaced

1. Headspace is excessive (the bolt closes, or almost closes, on a no-go gauge) and the barrel has previously been set back and requalified.

   Note: Requalification reduces barrel thread length. Standard M98 barrels should not have less than 6 1/2 full threads. M93~M96 barrels should not have less than 5 1/2 full threads.
2. The chamber is pitted, scratched, scored, miscut, altered, damaged, oversize, the wrong size, or is otherwise unserviceable. See Cerrosafe chamber casting on page 77.
3. The chamber throat is eroded, pitted, or misreamed too long or off center.
4. Barrel thread count is below the suggested minimum (see note, above) or barrel threads are miscut, undersized (less than standard 85% engagement), altered, or damaged.
5. Barrel mounting thread holes for scope bases or sights are drilled too deep or drilled into the barrel or chamber.
6. Sight dovetail is milled too deep.
7. The barrel has been overheated or otherwise damaged during band sight removal/installation.
8. The bore is rusted, pitted, scarred, rough, oversize/undersize, nonconcentric, bulged, irregular, or otherwise unserviceable.
9. The barrel and/or chamber has a liner installed. Barrel liners are found in some Spanish M93 and M95 models. Although bores and chambers may appear normal in these barrels, they were not built for, and must not be fired with, medium or higher pressure cartridges.
10. The barrel is sprung, stressed, out of round, flattened, bent, etc.
11. The barrel exterior is pitted.
12. M98 torque shoulder/barrel face is altered or damaged and barrel has been requalified previously.
13. M91~M96 torque shoulder or rear barrel face is altered or damaged and barrel has been requalified previously.
14. Rounds won't group and sight, cartridge, stock mounting and other problems have been ruled out.
15. A custom sporter, varmint, or target barrel is to be installed in the receiver.





CONTOUR SPECIFICATIONS

Blank Contours	Blank Weight	A	B	C	D	E	Finished Length	Blank Length
N/A	9-lb	1.250	UNTURNED BLANK				26	28
1	2 1/2-lb	1.200	.700	.550	2 1/2	2	20	26
2	2 3/4-lb	1.200	.750	.600	2 1/2	2	22	26
3	3-lb	1.200	.800	.625	2 1/2	2	24	26
4	3 3/4-lb	1.200	.875	.650	2 1/2	2	24	28
5	4 1/4-lb	1.200	.900	.700	2 1/2	2	26	28
6	5-lb	1.200		.750	3		26	28
7	6-lb	1.200		.875	3		26	28
8	7-lb	1.200		1.000	3		26	28

Figure 179- Shows a **Brownells/Shilen** prethreaded and chambered M98 Mauser sporter barrel, at top. The barrel contour illustration, at center, and dimensional table below, show diameters and contours of premium quality Shilen unthreaded, unchambered custom sporter, varmint, and target barrel blanks, available at the time of writing.

Considering shop labor costs, it is a false economy to install less than a high quality rifle barrel. Barrel performance problems can be virtually eliminated in advance by installing only high quality sporter barrels and premium quality varmint and target barrels.

Optional factors that also affect custom barrel performance include selection of correct rifling twist rate, barrel profile/weight, and the steel (chrome molybdenum or stainless) that the custom barrel will be made from. For example: a faster twist rate is needed to stabilize a longer bullet; a heavier barrel slows temperature rise and better equalizes its effect; throats in stainless steel barrels are more erosion resistant and accuracy is maintained longer, etc.

Replacement Barrel Options

1. Military Barrels- From time to time, military barrels in various levels of condition are offered for sale. **Caution**: inspect military barrels very carefully before purchasing. Before installing a military barrel, check thread count and cast the chamber and bore with Cerrosafe. Install only serviceable barrels. I would suggest using military barrels only on restorations. Although labor intensive, a better approach with restorations, when greater than military accuracy is desired, is to lathe turn a new barrel blank to duplicate the profile of the original military barrel.

2. Sporter Barrels- Sporter barrels can be ordered in both threaded and unthreaded configurations. Prethreaded barrels are short chambered and available in standard calibers, twists, and lengths (see current Brownells catalog). Headspace is typically adjusted with a T handle and finish reamer after the barrel is installed. Stepped chamber neck problems are easily solved by casting and measuring prethreaded barrel chambers and using a finish reamer of at least the same size. Premium barrel blanks are threaded, chambered, and adjusted to desired length by the riflesmith.

3. Target & Varmint Barrels- I suggest using only premium quality stainless .22, 6mm, and .30 caliber barrel blanks. To be considered premium quality, a barrel should meet the following requirements:

1. The barrel tube must be straight and stress relieved.
2. The bore must be smooth and free of flaws, irregularities, or blemishes.
3. The barrel exterior must be concentric with the bore.
4. Rifling lands and grooves must be uniform and of correct diameters.
5. The barrel must pass air gauge checks and bore scope inspection.

Using fully contoured, premium quality barrel blanks eliminates the barrel stressing problems caused by lathe turning and enables the riflesmith to concentrate on precision barrel fitting, chamber reaming, barrel installation, headspacing, and action work.

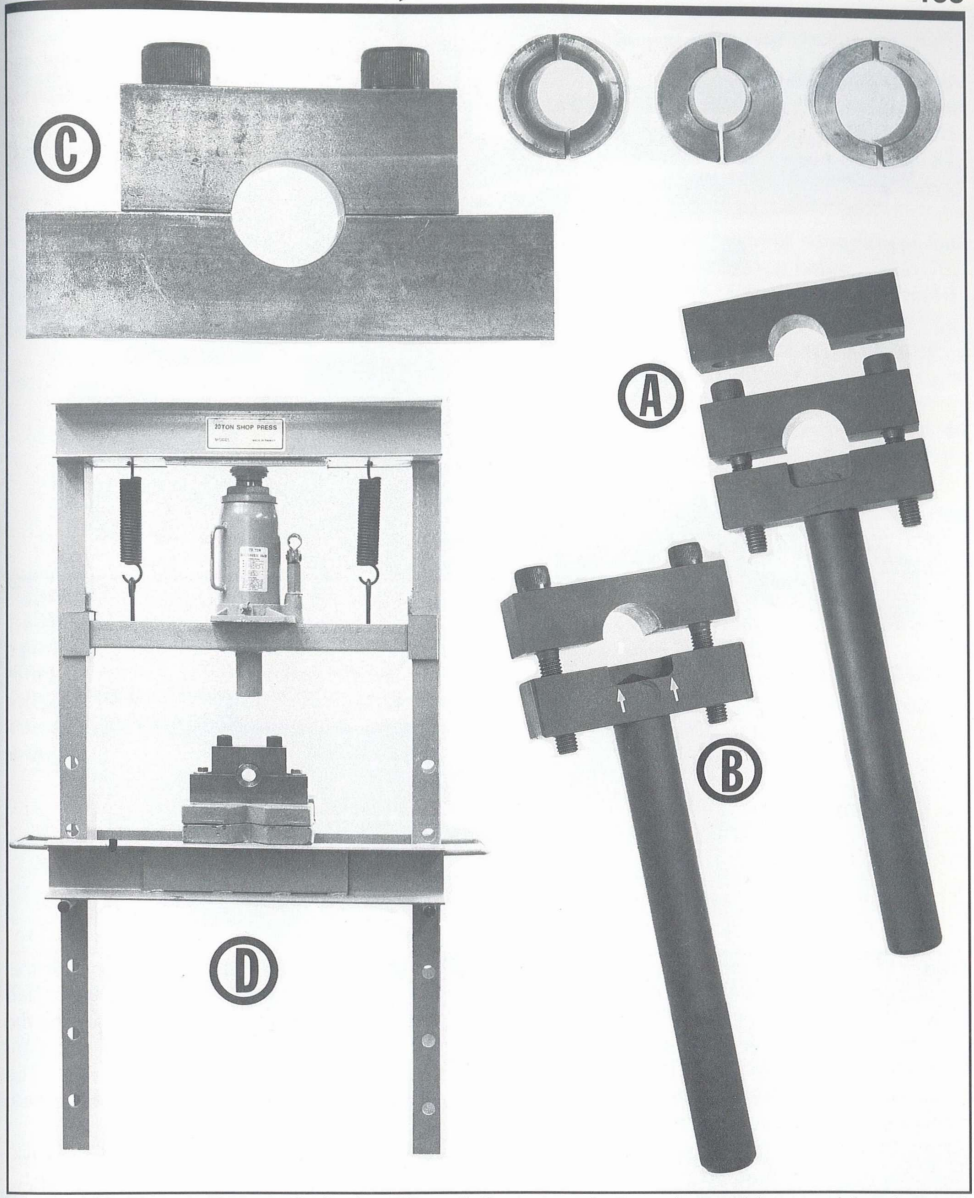


Figure 180- Shows a **Brownells Action Wrench System,** at **A**. Interchangeable wrench heads match receiver ring contour and support the top of the receiver ring. A small ring Mauser wrench head is shown, just above. I can't say enough about the superb design of this action wrench; when properly used, it eliminates the twisted, indented, squashed, or otherwise damaged receivers caused by incorrect tooling. Also see damaged receivers and cautions in figure 181. The action wrench, at **B**, modified by the author, has had the lug slot deepened for greater support of M91~M96 receiver rings. The Three V barrel vise, at **C**, and two inch wide aluminum barrel bushings (made by author), at top right, provide maximum bushing contact and barrel holding power. The barrel vise is shown bolted to a nonflexing base plate on the floor mounted press, shown at **D**. Stacked 3/8" steel plates can be used as an alternative support for the barrel vise. Hydraulic pressure is used to tighten the vise and secure the hold down bolts. Additional pressure is then used to hold the vise and prevent base plate movement on the press bed. Smaller three to five ton hydraulic bench mounted presses can also be used.

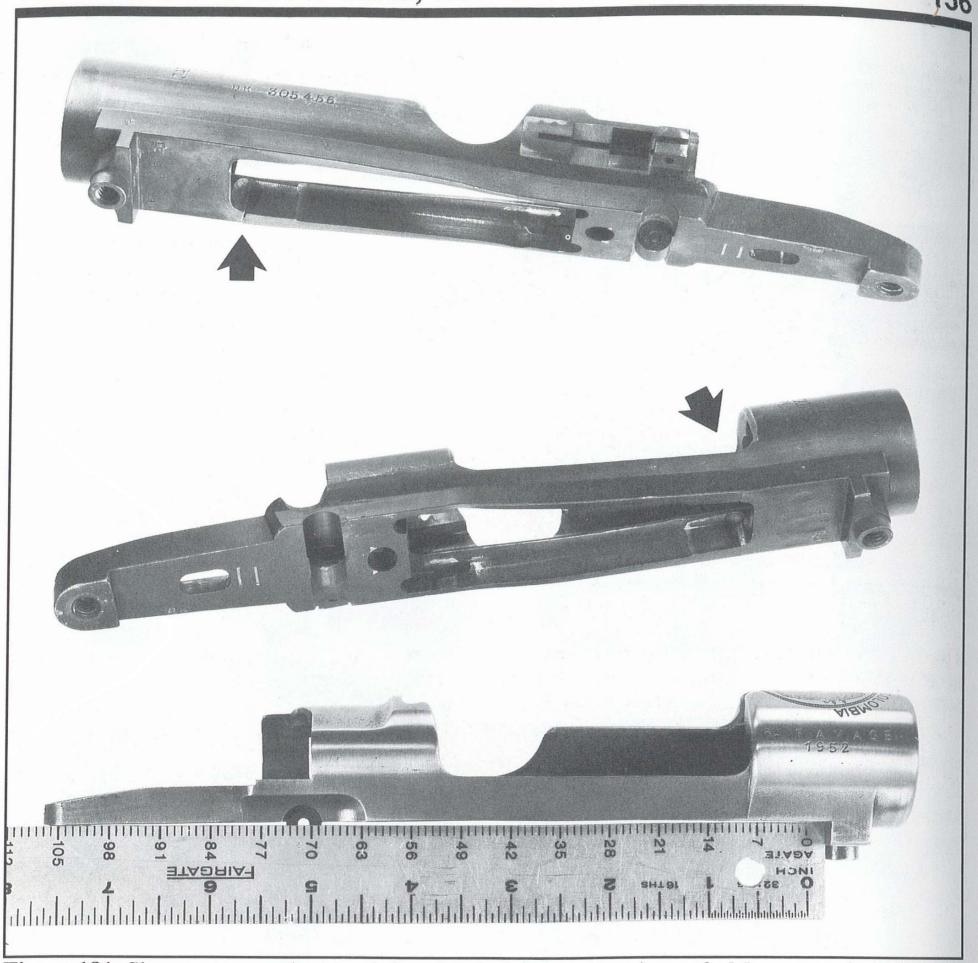


Figure 181- Shows, at top and center, left and right three quarter views of a Mauser receiver that was twisted and destroyed when improper tooling was used to remove the barrel. The receiver was twisted to the extent that it cracked, see arrows above. Correct tooling was apparently used in removing the barrel from the M98 receiver, at bottom. This receiver was probably bent by pulling, or leaning on, the receiver tang when pressure was applied to the wrench handle while unthreading the barrel. The small ring receiver, at top, had indentations on the top of the ring caused by a wrench head that did not fit the receiver ring correctly.

Damaged receivers are shown above to make the point that correct tooling and correct setup are absolutely necessary. In some respects, Mauser M98 and M94/M96 Swedish receivers in excellent condition can be considered well machined works of art. Don't ruin them.

Always check receivers for possible pre-existing tweak or bend before installing the barrel in a barrel vise or the receiver in an action wrench. Receivers can't be easily checked for bend with a receiver mandrel with the barrel installed. A workable alternative is to visually inspect the receiver and check the flat receiver bottom against a trued gauging surface. The bottom must fully contact and rest level on the flat gauge surface. Don't use receivers that do not pass this test.

Note: In rare circumstances, a Mauser receiver will be found cracked through the extractor slot on the right side of the ring after barrel removal. Some experts theorize this is caused by barrel/receiver ovalling from excessive factory proof loads. When an attempt is made to rotate a slightly ovalled barrel, force is applied to the receiver threads and is, in some cases, great enough to stretch and break the receiver. Correct tooling and action wrench receiver ring support will minimize this problem, but cannot eliminate it in a worst case situation.

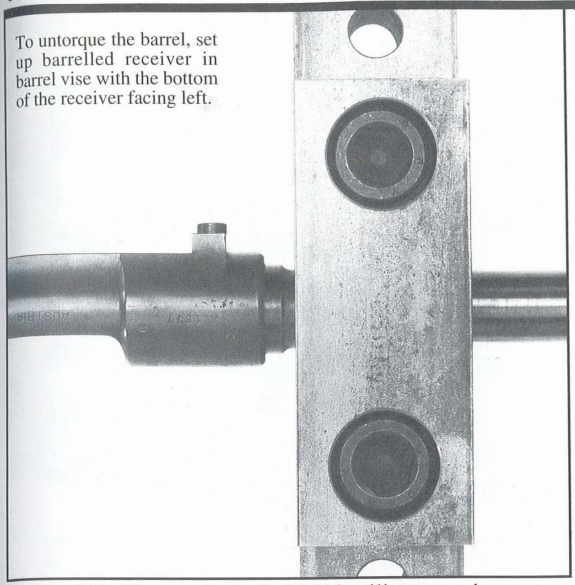


Figure 182- Shows a barrelled M98 military receiver set up in a Three V Barrel Vise to unthread the barrel. The receiver is positioned with the bottom facing left before tightening the barrel vise so that, when installed, the action wrench handle will point 90 degrees to the left. Mauser barrel threads loosen with counter clockwise rotation of the action wrench handle, as the receiver is viewed from the rear.

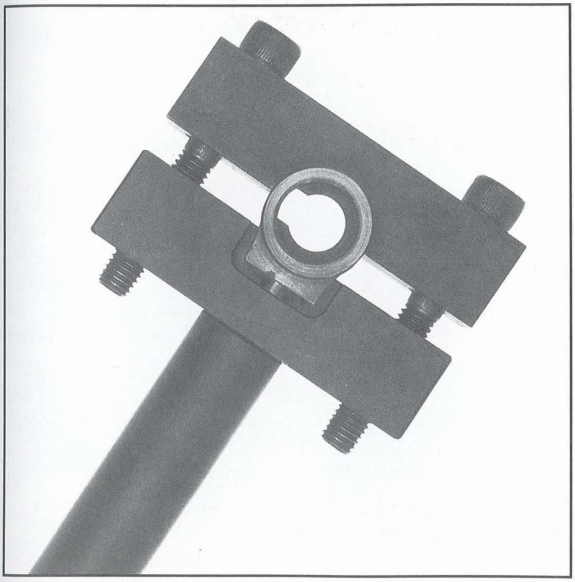


Figure 183- Shows a front view of a Mauser M98 receiver installed in a **Brownells Action Wrench.** Mauser M91~M98 receiver ring diameters tend to vary somewhat. When a reciever ring is found slightly small (the correct wrench head fits on the receiver ring with clearance), fill in the space with brass shim stock to provide 100% support for the receiver ring while the barrel is being untorqued.

Barrel Removal

Before attempting to remove a barrel from any Mauser receiver, see correct tooling and receiver damage cautions in figures 180 and 181. Check and set up for barrel removal as follows:

1. Check receiver straightness and overall condition before removing the barrel. Do not install barrels in Mauser receivers that are sprung, bent, or otherwise unserviceable.
2. Measure diameter of the straight barrel shank just ahead of receiver.
3. Bore an aluminum barrel vise bushing blank to the diameter of the barrel shank. Then, cut the vise bushing in half. See barrel vise bushings at the top of page 155.
4. Coat the barrel vise, bushing, and the barrel in the bushing contact area with as much powdered rosin as possible.
5. Position the barrel in the barrel vise with the bottom of the receiver facing to the left. See figure 182.
6. Snug the barrel vise bolts and apply hydraulic pressure to the top of the barrel vise. Retighten the barrel vise bolts and reapply pressure, etc., until the bolts are at maximum tightness. Then increase press hydraulic pressure on the vise to keep the barrel vise from moving when receiver torque is broken.
7. Install the action wrench on the receiver with the handle pointing horizontally to the left. See figure 183. Use brass shim stock to fill in between the wrench head and the receiver ring, if receiver diameter is smaller or contour is different than the wrench head radius. Shimming the wrench head helps support the receiver ring when the action wrench is impacted to loosen the barrel/receiver thread joint.
8. Tighten the action wrench head until the screws are snug and the wrench feels solid on the receiver ring. Do not over tighten the wrench.
9. Recheck barrel vise bolt tightness and hydraulic pressure as discussed in figure 184.

Barrel Removal, Continued-

10. Grasp the action wrench firmly. Apply a quick downward pressure on the wrench handle, putting body inertia into the movement. About half of the Mauser receivers I have removed have broken torque and unthreaded from barrels with only this much effort.

11. If the torque joint does not break, install a 36" section of 1 1/4" pipe over the action wrench handle to extend it. Then, apply pressure at the end of the extension, as above, to separate the barrel/receiver torque joint.

12. If the barrel/receiver torque joint still does not release, apply firm downward pressure on the wrench handle extension and impact the end sharply with a 5 pound lead hammer. At this point, all but the worst of the overtorqued, galled or frozen torque joints, and/or ovalled barrels, will separate crisply. There is a certain risk involved in using additional force with barrelled receivers in this condition. See cautionary note in fig.181.

Note: Action wrench receiver support, barrel vise contact area, and barrel vise gripping strength are critical in separating overtorqued military barrels and receivers. If a barrel vise has sufficient contact surface and can be tightened enough to prevent barrel slippage, even an overtorqued, or slightly oval military barrel will break torque with one or two sharp impacts.

Barrel Slippage Caution

Barrel slippage can occur in a barrel vise with a barrel bushing contact area that is too small for a given torque load. Slippage can also occur in correctly sized barrel vises that haven't been coated with enough rosin and/or that have not been tightened securely on the barrel.

When barrel slips occur, impact energy is not distributed to the barrel/receiver torque joint, but instead to action wrench contact points on the outside of the receiver. Impact energy is wasted and can, in some cases, peen flat spots on the outside of the receiver.

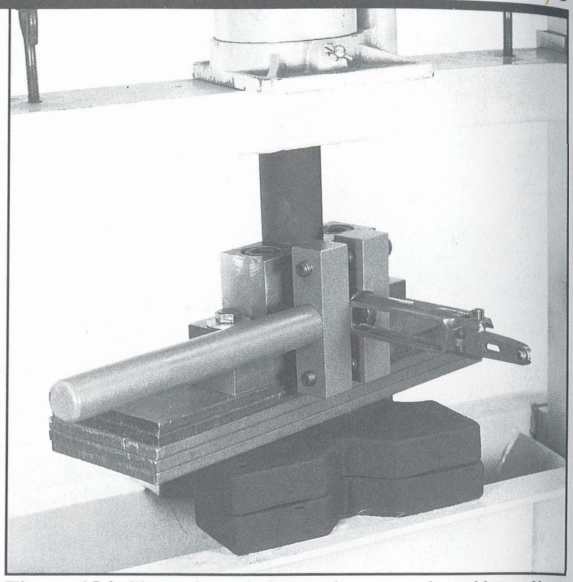


Figure 184- Shows barrel vise, action wrench and barrelled Mauser receiver set up in a shop press, ready to untorque the barrel/receiver thread joint. The press is used to tighten the barrel vise bolts and to prevent the tooling from moving on the press bed. Hydraulic pressure is increased and barrel vise bolts retightened to prevent the barrel from slipping before pushing on, or impacting, the action wrench handle.

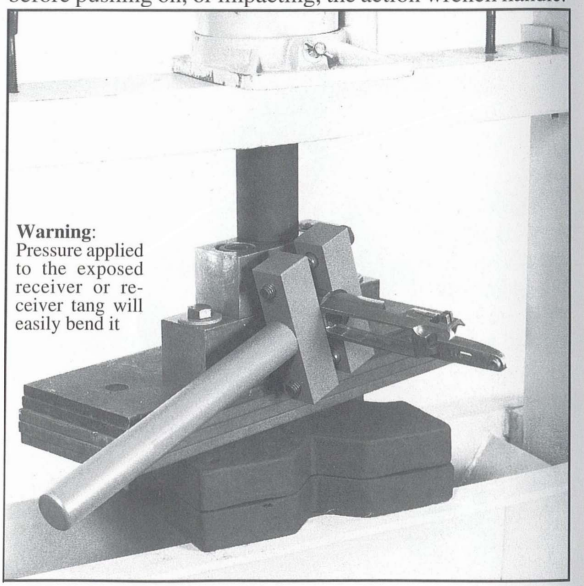
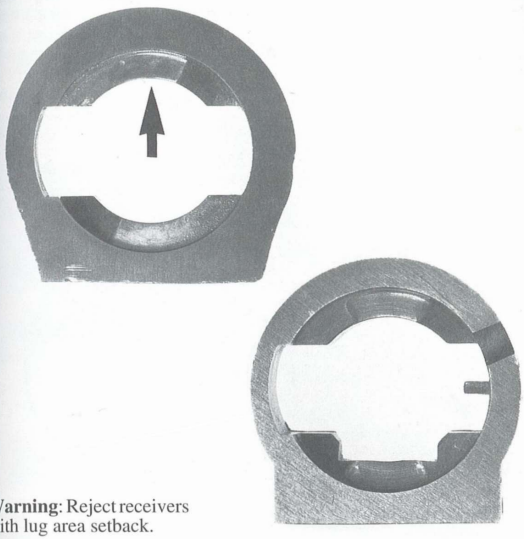
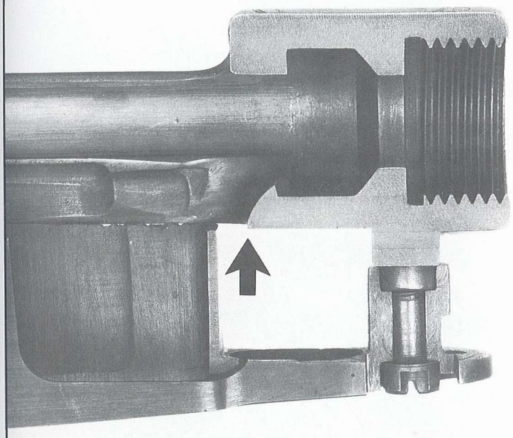


Figure 185- Shows the receiver/barrel torque joint broken. When torque joints are overly tight, an extension made from a 36"section of 1 1/4" pipe can be installed over the action wrench handle. The increased leverage generated by the wrench handle extension permits crisp impact separation of most receiver/barrel torque joints when the extension is moved quickly or tapped with a lead hammer.



Warning: Reject receivers with lug area setback.

Figure 186- Shows M98 and M93 Spanish type receivers that were sectioned just ahead of the receiver lug engagement area. The M98 receiver lugs show only light wear polishing on the bottom lug and .004" wear seating at the top lug. In this case, a slightly off tolerance top bolt lug wore itself in. Both of the M93 receiver lugs are set back about .009".



Warning: Reject receivers with modified magazine feed ramps. Material removed from the ramp weakens the bottom lug area.

Figure 187- Shows a sectioned M98 receiver. The feed ramp behind the bottom receiver lug had been altered to feed .375 H&H cartridges. A 3.400" .30-06 length magazine well is shown installed on the altered receiver to illustrate just how much metal was removed. Ramping M98 actions beyond the point needed to feed .30-06 length cartridges, shown in figure 243, weakens receivers and is not recommended.

Receiver Inspections Before Barrel Installation

Receiver lugs, torque shoulders, and barrel threads can be detail inspected only after barrels have been removed.

Receiver Lug Area Inspection

Depth of Mauser M91~M98 receiver lug area case hardening and core hardness varies somewhat with the model, manufacturer, and production lot. M94/M96 Swedish Mausers and the M98's made after 1936 have the most consistent case hardening depth and core hardness. With the exception of a few late M98K's and a few South American made M98's, over carburized and brittle Mauser receivers are very rare, to my knowledge. Spanish made Mauser receivers are typically soft and susceptible to lug area setback. The example in figure 186 was caused by firing commercial cartridges. Rebarrelling of M91 and M93~M95 actions should be limited to restorations; only receivers without lug area setback should be used. To be considered serviceable, Mauser receiver lugs should show only light bolt lug wear and surface wear seating of .002" or less. Due to parts manufacturing tolerances, some amount of unequal lug surface wear and lug wear seating is normal.

Acceptable lug wear seating is defined as any combination of bolt lug related flattening and light surface wear in the receiver's lug bearing area not exceeding a depth of .002". The M98 receiver in figure 186 has .004" wear seating at the top lug. This receiver could be rebarrelled if the original bolt was used; the bolt and receiver lug surfaces lapped-in; and the bolt and receiver were then reheat treated.

Receiver lug setback is a different condition. It is identified by the presence of bolt lug impressions in the receiver's lug surfaces. See M93 Spanish receiver in figure 186. Setback, in any receiver, would indicate that core material is too soft and/or that the receiver was pressure abused. Thin case hardening permits excessive lug area wear. See bolt hardness, receiver hardness, and reheat treating on pages 41, 70, and 71.

Over Ramped M98 Receivers

The longer belted magnum cartridges, such as the .300 and .375 H&H magnums, are much too long for standard (8 3/4") military and commercial M98 Mauser actions. See figure 187. Some gunsmiths alter ramps in standard length M98 receivers to feed mid-length and longer belted magnum cartridges, believing these conversions are safe. This alteration, however, seriously weakens the bottom receiver lug and should not be done.

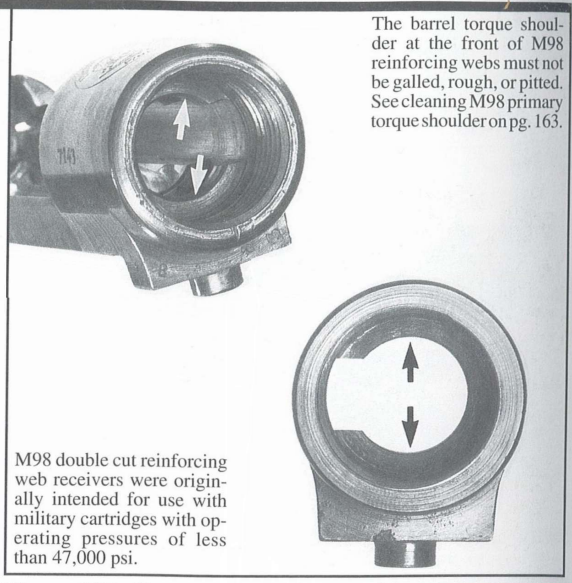
Oberndorf commercial sporter actions were made in a 9 1/4" magnum length for this reason. Do not alter standard M98 Mauser ramps beyond .30-06 cartridge length; instead, locate a commercial M98 magnum length action or convert a standard action to fire the shorter magnum cartridges.

M98 Reinforcing Webs and Primary Barrel Torque Shoulders

Internal reinforcing webs in M98 receivers are open on the right side for extractor clearance. The front face of the reinforcing web is the primary barrel torque shoulder. If this surface is rough, pitted, altered, or damaged, M98 barrels will not torque correctly. FN made military and commercial M98 receivers have an extra tooling access cut on the left side. See figure 188. Some experts maintain that these typically soft receivers are more prone to stretch when higher pressure commercial cartridges are fired. I would suggest limiting the use of these receivers to rimless type commercial standard pressure cartridges.

About Receiver Ring Diameter and Wall Thickness

Diameters of the small ring Mauser receivers I have measured have ranged from 1.290" to 1.318", with 1.30" being standard. Military M98 receiver rings measured from 1.396" to 1.425" in diameter. Except for the small ring M98's (which measure 1.300"), most M98 rings have



The barrel torque shoulder at the front of M98 reinforcing webs must not be galled, rough, or pitted. See cleaning M98 primary torque shoulder on pg. 163.

M98 double cut reinforcing web receivers were originally intended for use with military cartridges with operating pressures of less than 47,000 psi.

Figure 188- Shows a standard M98 military receiver with full reinforcing web, at right. An FN M98 military receiver with double cut reinforcing web is shown at top left. The double cut web modification facilitated manufacture of standard length M98 receivers intended for military cartridges. The primary torque shoulders at the front of the reinforcing web, see arrows, must be smooth and level.

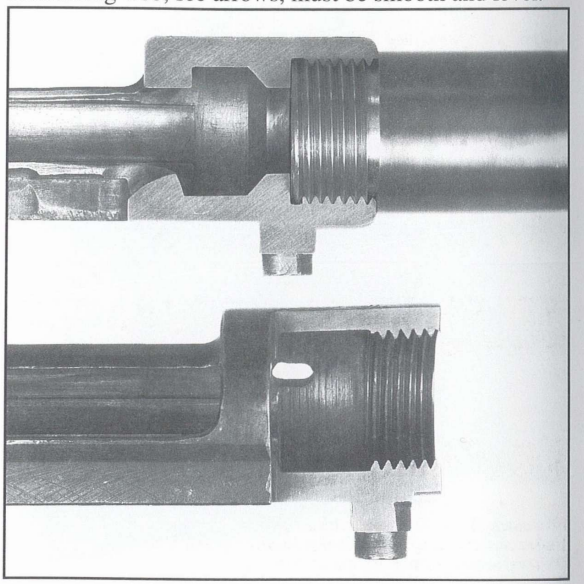
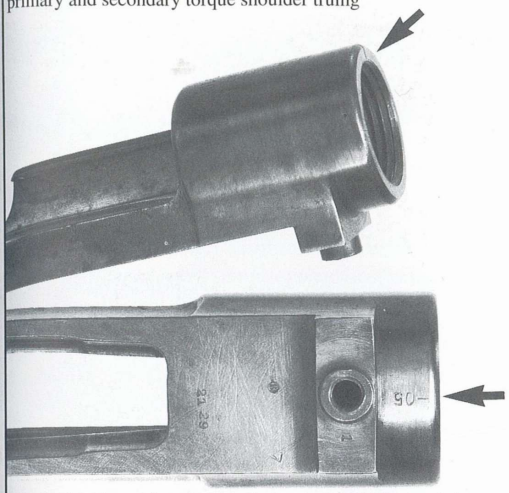


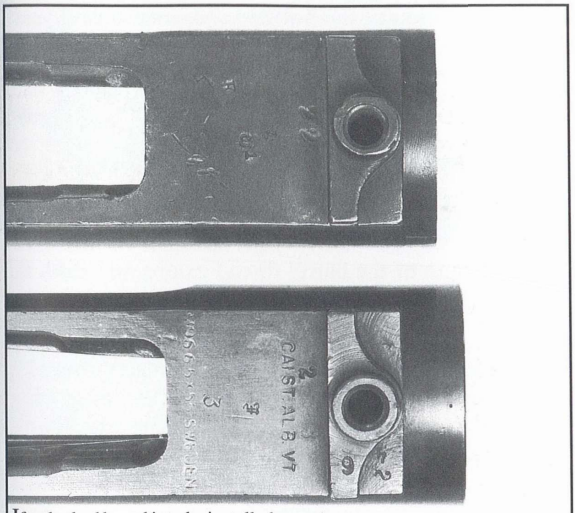
Figure 189- Half sectioned M98 and M95 receivers show differences in receiver ring wall thickness. Increased thread bearing area; greater right side wall thickness; and an internal reinforcing web, combine to make large ring M98 receivers much stronger. Note that the thin (and soft) M95 receiver is out of round and distorted in the barrel thread area.

See figures 193, 196, and 197 for large ring M98 primary and secondary torque shoulder truing



If a clocked barrel is to be installed, punch an index mark in the 6:00 o'clock position on the bottom of the receiver ring.

Figure 190- Shows secondary torque shoulder at the front of a standard large ring M98 receiver. This surface should be true and at 90° to the centerline of the barrel and receiver. The diameter of the flat secondary torque shoulder should be equal to, or slightly larger than, the shoulder diameter of the M98 barrel that is to be installed.



If a clocked barrel is to be installed, punch an index mark in the 6:00 o'clock position on the bottom of the receiver ring.

Figure 191- Shows barrel torque shoulders on a Mauser M93 receiver, at top, and an M96 receiver, below. Mauser M91~ M96 barrels torque only on the flat shoulder on the front of the receiver. The receiver barrel torque shoulder must be true, and at 90° to the centerline of the barrel and receiver. See figures 196 and 197 for lathe truing of receiver barrel torque shoulders.

Ring Diameter and Receiver Wall Thickness, continued-

measured just at 1.410", which is considered standard. Receiver rings on 8 3/4" and longer Oberndorf sporter actions also measure 1.410". Use these diameters as a reference to determine if rings have been ground and wall thickness reduced.

Inspect Large Ring M98 Secondary Barrel Torque Shoulder

This surface must be finished at 90° to receiver/barrel centerline. The diameter of the trued portion of the flat secondary torque shoulder surface must be large enough to match the diameter of the replacement barrel torque shoulder. If scored, pitted, or damaged, this surface can be recut and trued,on a one time basis, subject to the following limitations:

1. Not more than .025" may be removed from the front of the receiver.
2. The remaining distance from the primary torque shoulder inside the receiver to the secondary shoulder, at front, must not be less than .600".
3. At least 7 full barrel threads must be left in the receiver.

Carefully inspect receivers before making shoulder adjustments. If surface pitting or damage can't be cleaned up within the above limits, do not use the receiver. See figures 196 and 197 for secondary torque shoulder adjustment.

Inspect M91~M96 Receiver Barrel Torque Shoulder

M91~M96 receivers have only a single external barrel torque shoulder. This shoulder surface also must be square and at 90° to receiver/barrel centerline. See figure 191. Barrel torque shoulders can be recut and trued on a one time basis subject to the following limitations:

1. Not more than .020" must be removed from the torque shoulder.
2. At least 6 1/2 full barrel threads must be left in the receiver.

Carefully inspect receivers before shoulder adjustment. If surface pitting or damage can't be cleaned up within the above limits, do not use the receiver.

Prepare Receiver for Rebarrelling

Rebarrelling and other custom riflesmithing work should be well planned to prevent expensive mistakes. A logical work sequence is necessary to avoid wasting shop time or having to do the same step more than once. All receiver preparation for rebarrelling, including lug lapping or resurfacing, cosmetic repairs, polishing, and reheat treating, should be completed before barrels are installed.

An experienced custom riflesmith may use a work sequence that is somewhat different than that given below, but that also delivers a top quality product. If you have a performance proven method, by all means use it. Otherwise, I have found that a receiver inspection and fitting sequence similar to that listed below and discussed on the following pages to be most useful and reliable. This sequence prepares Mauser receivers that have passed inspections to this point for rebarrelling or barrel requalification.

1. Clean and inspect the receiver barrel threads. Check for rough or slightly tapered and/or slightly oval threads. This step is done first to determine basic replacement barrel thread requirements and to prepare the receiver threads, if necessary, for the installation of threaded receiver mandrels and lug lapping, bolt facing, and primary torque shoulder resurfacing tools.

2. Clean and true the primary barrel torque shoulder located at the front of the reinforcing web inside M98 receivers. Ridges and high spots must be removed from this surface before barrel installation. The primary torque shoulder must be smooth, level, and at 90° to receiver/barrel centerline. If this surface is galled, pitted, damaged, or has been altered, the barrel will not torque correctly. M98 barrel thread extension length is measured from this important surface.

3. Mate and lap the bolt and receiver lugs. This step equalizes small bolt lug and receiver lug plus/minus manufacturing tolerance accumulation that has not yet wear seated out and makes the bolt lugs engage and bear uniformly on the receiver bolt lug engagement surfaces. Once this is done, bolt position in the receiver and final forward position of the bolt face are mechanically set. Headspace is then referenced from final bolt face position. After mating, mark the underside of the bolt handle with the receiver serial number to prevent mixup.

4. If the bolt face requires resurfacing or the shell head recess in the bolt face is to be opened to accommodate a larger diameter magnum cartridge head, this work is done next. This is important because headspace is referenced and set from the final position of the bolt face.

5. Clean and true the secondary barrel torque shoulder on M98 receivers. The distance from the primary torque shoulder inside an M98 receiver to the secondary torque shoulder surface at the front of the receiver ring determines the final length of the barrel thread extension. Both the primary and secondary barrel torque shoulders on an M98 receiver must be trued before M98 barrels can be finally adjusted to correct fit.

6. Clean and true the barrel torque shoulder on M91~M96 receivers. The distance from the top bolt lug (with the bolt in the locked position) to the barrel torque shoulder at the front of an M91~M96 receiver determines the final length of the barrel thread extension. The receiver barrel torque shoulder must be trued before barrel shoulders can be finally adjusted to correct fit.

7. Hone bolt lug ways, make small exterior cosmetic repairs, and prepolish the receiver.

8. Send in the mated receiver and bolt body for reheat treatment. See page 71.

With the above work done, the receiver can be measured for exact barrel thread extension length and final barrel fitting can begin.

Note: Otherwise serviceable M98 receivers in excellent cosmetic condition are sometimes found with lug seats that are lightly or moderately set back due only to receiver softness, rather than pressure abuse. These receivers can be restored to use by having the lug areas resurfaced by a precision, Mauser qualified metalsmith. Bolt bodies must be mated at the same time. Both the receiver and the bolt body must be reheat treated after this work.

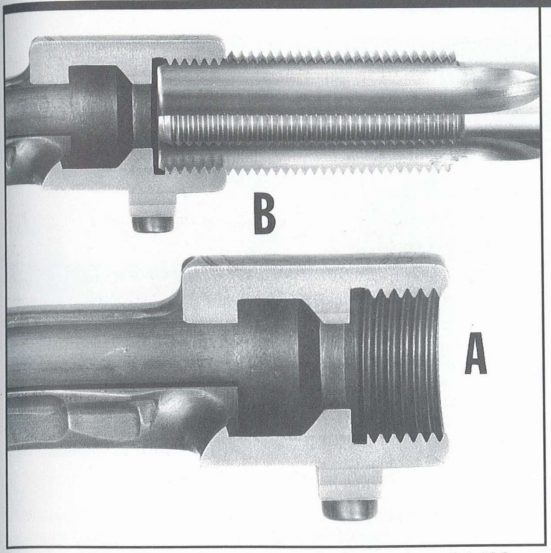


Figure 192- Shows barrel threads in sectioned M98 receiver, at **A**, after cleaning with a Foredom tool and small wire wheel. When U.S. made prethreaded barrels are to be installed, slightly rough receiver threads (that are not oval or grossly undersize) can be cleaned with a tap, as shown at **B**. A 1.100"-12 TPI tap can be used with large ring receiver threads and a .980"-12 TPI tap with small ring threads.

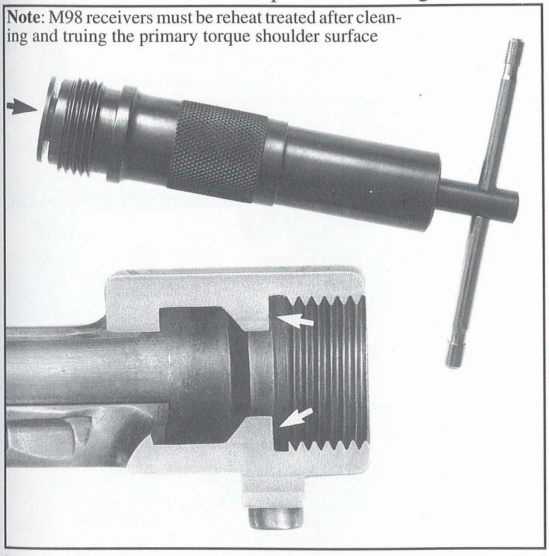


Figure 193- The sectioned M98 receiver, at bottom, has had threads cleaned and is now ready to have the primary torque shoulder surface, see arrows, checked, trued and polished. The diamond abrasive head on the spot facing tool, designed by author and shown at top, removes high spots and rough areas and cuts through any remaining case hardening to level and true the primary torque shoulder surface.

Clean Receiver Barrel Threads

1. Clean the receiver barrel thread area with solvent and a bristle brush. After cleaning, blow the threads and recesses dry with a pressure nozzle.
2. Remove any remaining dried lubricant and/or dirt residue from the thread bottoms with a wire brush.
3. After the inside of the receiver ring and the receiver barrel threads are clean and dry, closely inspect for possible cracks across the threads or through the outside of the ring, particularly across the extractor slot on the right side of the receiver. If there is any doubt about condition, have the receiver magnafluxed.

Note: The few cracked M98 receivers I have examined were cracked when twisting out a pressure ovalled barrel with incorrect tooling.

About Chasing Barrel Threads in Mauser receivers-

Chasing and cleaning the 55° Whitworth barrel threads in a Mauser receiver with a U.S. standard 60° tap can be helpful, in some cases, when a prethreaded U.S. made sporter barrel is to be installed. U.S. made barrels typically have 60° U.S. standard vee type threads.

Caution: Slightly oval, slightly tapered, or slightly undersize receiver threads can bind or seize the tap. If this begins to happen when cleaning threads, back out the tap before it binds or sticks and damages either the receiver or the tap.

Clean and True M98 Receiver Primary Torque Shoulder

The primary torque shoulder is checked and trued after the receiver threads have been detailed and the receiver has been determined to be uncracked. See figure 193.

1. Inspect the primary torque shoulder inside the receiver. If the surface is level and smooth it can be left as is.
2. If the surface is uneven, pitted, rough, galled, or not at 90° to receiver centerline, dress and true with a facing tool. See figure 193. Remove no more metal than needed to clean and true the surface- and in no case more than .020".
3. Remove the facing tool, solvent clean the receiver, and recheck the primary torque shoulder surface.

Check Bolt/Receiver Lug Fit

Plus or minus bolt/receiver lug tolerances can cause unequal top or bottom lug engagement and bolt/receiver stress. When engagement differences are very small, receiver lug surface wear seating usually equalizes the difference. When lug surface engagement is not equal, the bolt and/or receiver flex under firing pressure. This, in turn, affects accuracy.

Equalize bolt lug engagement and lap bolt/receiver lugs as follows:

1. Detail clean and dry the receiver and bolt body. Coat both the receiver and bolt lugs with Dykem Blue.
2. Install the bolt and lapping fixture shown in figure 195 and cycle the bolt about 20 times to get a surface contact pattern. Do not use lapping compound at this time.
3. If machine ridges, high spots, nicks, or burrs on the bolt lugs limit full engagement or cause irregular lug contact, carefully level the bolt lug engagement surfaces with a fine Eze-Lap diamond hone.

Warning: Remove only enough surface material (usually just a few thousandths) to equalize and level the bolt lugs and bring them into full contact with the receiver lugs. Bolt lug engagement surfaces must be kept square and at 90° to bolt centerline.

Lap Bolt/Receiver Lugs

4. Recoat the lug engagement surfaces with Dykem Blue and recheck surface contact pattern.
5. Put a bit of #600 silicone carbide lapping paste on the receiver lugs.
6. Install bolt. Push forward to avoid scraping the lapping compound off the lugs when closing the bolt.
7. Apply a dab of light grease to tip of plunger and install and snug lapping fixture in receiver. See fig. 195.
8. To lap surfaces, rotate bolt upward and back about 45°. Usually, about 50 passes will surface the lugs.

Caution: Control bolt position when lapping to prevent round-off at receiver lug engagement cam corners.

9. Remove lapping compound with solvent and recoat lugs with Dykem Blue. Recheck surface contact pattern. Relap if less than 95%.

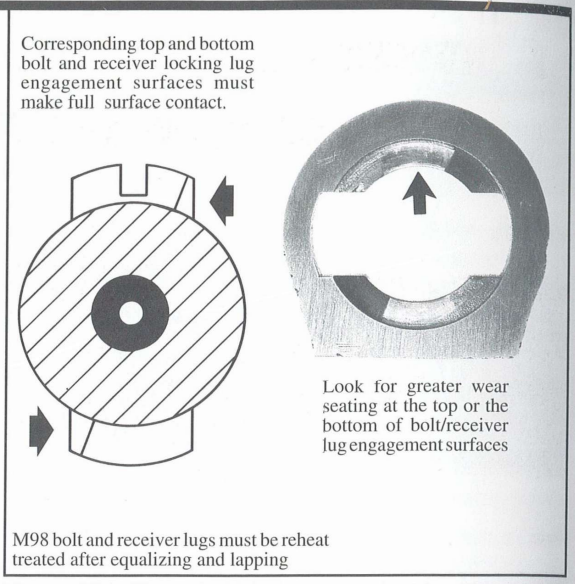


Figure 194- Shows M98 bolt/receiver locking lug engagement and lug camming surfaces. Surfaces are similar on M91~M96 bolts. Locking lug engagement surfaces should show only shiny wear polishing. Greater surface seating at one of the lugs indicates plus/minus lug tolerance accumulation. Wear seating may or may not equalize the difference.

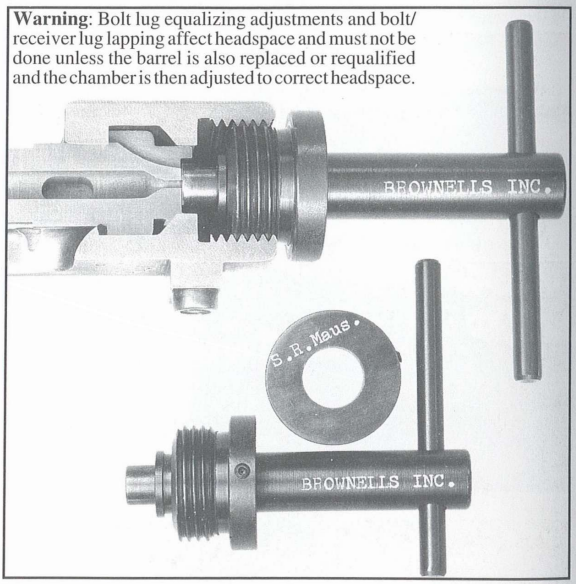
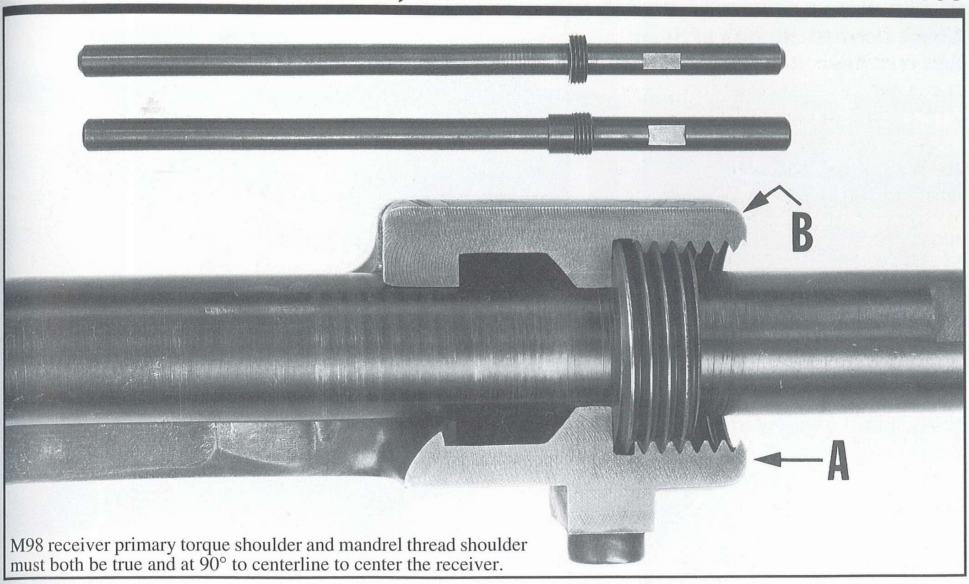


Figure 195- Shows a cutaway M98 receiver and bolt with a **Brownells Bolt/Receiver Lug Lapping Fixture** installed. Silicone carbide lapping paste is applied to the receiver lug area before installing the bolt. The spring loaded plunger in the center of the fixture pushes the bolt body back and holds the bolt lugs squarely against the receiver for even lapping.



M98 receiver primary torque shoulder and mandrel thread shoulder must both be true and at 90° to centerline to center the receiver.

Figure 196- Shows a large ring Mauser M98 receiver with receiver facing mandrel installed and tightened. Brownells' small and large ring Mauser receiver facing mandrels are shown separately, above. The receiver and mandrel are installed on the lathe as shown in figure 197. The secondary torque shoulder flat, at **A**, is cleaned, trued, and adjusted to equal or exceed the diameter of the replacement barrel's shoulder. The receiver's outside radius, at **B**, is then recontoured and polished on the lathe for neat appearance. See page 161 for M98 secondary torque shoulder and M91~M96 torque shoulder maximum adjustment data.

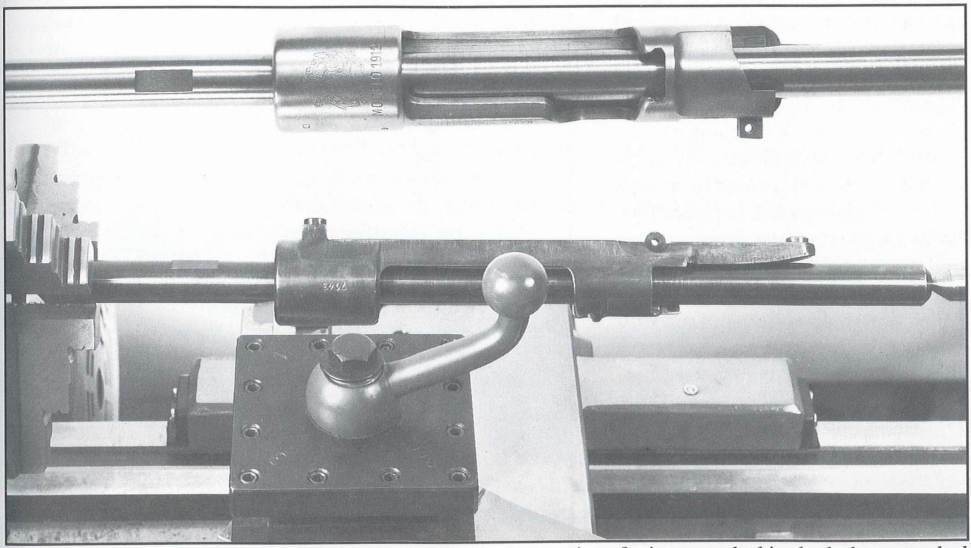


Figure 197-Shows an M98 Mauser receiver set up on a receiver facing mandrel in the lathe; mandrel and receiver are shown separately, above. The mandrel is positioned with the receiver ring facing the lathe chuck. A live center is installed in the lathe tailstock to center the opposite end of the mandrel. The lathe is set at low speed and the mandrel and receiver are rotated counterclockwise to keep the receiver tight on the mandrel threads. The torque shoulder, at the front of the receiver, is cleaned and trued to receive the replacement barrel shoulder. M98 receivers are lightly radiused on the outside corner. M91~M96 receivers are lightly 45° chamfered to break the sharp outside corner edge.

About Cosmetic Repair of Small Receiver Pits-

Fortunately, most receiver pitting is found below the stockline. Deeply or heavily pitted Mauser receivers must not be rebarrelled or used. See figures 83 and 198. Tag these receivers and mark as unserviceable.

Many serviceable military receivers are found with small exterior pits that may require some amount of cosmetic repair. Serviceable Mauser receivers that are lightly pitted below the stockline and are intended for utility grade hunting rifles can be sandblasted before hot oxide bluing to make pitting less obvious.

In many cases, light pits below the stock line can be ground off, as discussed below and in figure 200. Receivers that are carefully ground can then be polished and blued normally. More involved cosmetic repairs are labor and cost intensive. Some receivers may not be worth the cost involved.

Grinding Off Receiver Pits

Below stockline receiver pits can be ground off as follows:

1. Adjust a hard #150 surface grinding wheel to approx. 2 1/2" or 3" diameter. This is an exellent use for worn surface grinder wheels.
2. Set up large ring M98 receivers on a receiver mandrel secured in surface grinding fixture shown in figure 200. **Note**: Lower receiver grinding also can be done on a lathe using a toolpost grinder and the same mandrel.
3. Position the mandrel and receiver in the grinding fixture so that the grinding wheel first contacts the bottom outside corner of the recoil lug.
4. Grind in .005" passes to remove pits. Do not remove more than .035" from the side of the recoil lug.

Caution: Do not grind more than .010" from the lower receiver ring surface at the top of the grind. See figure 200.

5. Then, set up similarly and grind the lower sides of the receiver behind the ring. Do not remove more than .010" from the receiver at the top of the grind.

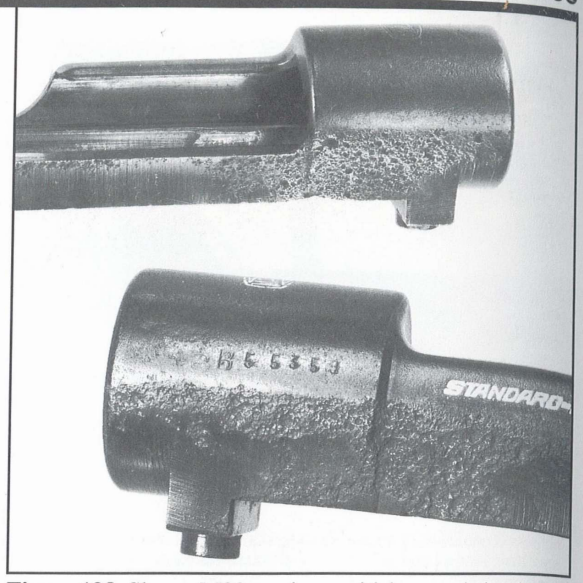


Figure 198- Shows M98 receivers with heavy pitting below the stock line. Pitting is much too deep to grind off. Receivers with light below stockline pitting that can be cleaned off within the .010" and .035" top/bottom limits, as discussed in figure 200, can be ground and rebarrelled. Receivers with deeper pitting should be replaced.

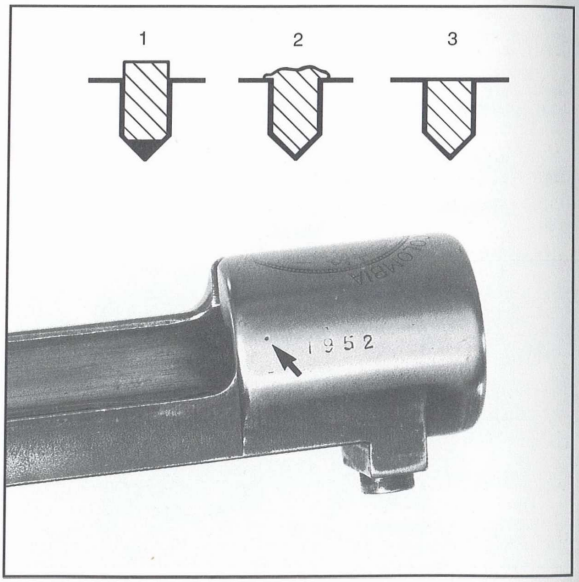


Figure 199- Shows an otherwise cosmetically acceptable receiver with a single .025" diameter pit above the stock line. A cold repair method used by some metalsmiths involves drilling pits out with a small dental burr; making a plug to fit the hole from mild steel or 3 1/2% nickel welding rod; peening and expanding the plug to a tight fit, and then filing off the excess and polishing the surface.

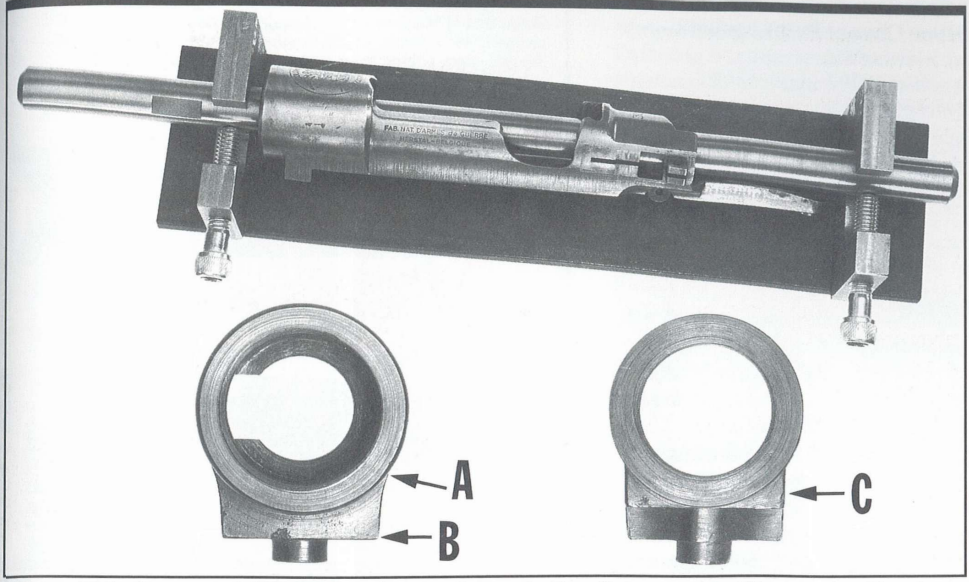


Figure 200- Shows an M98 receiver in a surface grinding fixture at top. The receiver has been reground on the sides to remove light pitting below the stock line. A magnetic chuck used on the surface grinder bed permits easy alignment of the grinding fixture and the receiver for full length grinding passes. Front views of M98 and M95 receivers are shown at bottom.

Full wall thickness must be maintained in Mauser receiver side walls and in receiver ring barrel thread areas. For this reason, top of regrind depth at the bottom of an M98 receiver ring, shown above at **A**, and the sides of the receiver behind the ring must not be deeper than .010". Regrind depth at the bottom corner of the recoil lug, shown at **B**, must not exceed a depth of .035". Grinding to remove pits on the flat sides of M91~M96 receivers must not notch into the receiver ring or exceed a depth of .020" per side.

For best appearance, the top of the regrind on an M98 receiver must not be more than .020" higher than the original grind. Additional pitting can sometimes be removed by hand polishing and feathering in the edge of the regrind to the original curve on the outside of the receiver ring. Although there can be surprises (small pits sometimes open into others, etc.) most small, below stockline pits are easily removed with this procedure.

Final grading of receiver cosmetic condition can be made at this point. When reinspected after grinding, receivers that show no further pitting and/or blemishes can be regraded to excellent exterior condition and barrelled for use in better grade custom sporters. Depending on final appearance (number of pits remaining, etc.), the remaining receivers can be bottom sandblasted and top polished, or fully sandblasted with fine silica sand and rebarrelled for utility grade sporting rifles. Mauser receivers must be reheat treated after grinding.

Some metalsmiths pick out small remaining pits, clean surfaces with trichloroethane, and MIG weld "cold" (low heat) spot puddles over the top of pits. Although some metalsmiths have developed this technique to a near art form, I don't recommend this as a shop procedure because of several shortcomings associated with it:

1. Critical heat control: cold spot puddle heat must do no more than warm the receiver ring.

2. Cratering: cold spot puddles must not crater at edges more than can be cleaned by levelling the puddle and block sanding the surface.

3. Surface match: weld filled areas usually do not match when blued. Annealing the receiver, reheat treating, acid striking, and rust bluing the receiver will usually blend in weld repair areas.

Hone Curved Bolt Lug Guideways at Sides of Receiver

1. Install FN made M98 receivers and M91~M96 receivers on a barrel stub secured in a bench vise. See figure 201.
2. Install #320 followed by #400 sandcloth on the guideway polishing tool. Wet the sandcloth with oil or solvent and hone the curved bolt lug guideway surfaces.
3. Change sandcloth contact with each stroke so that the curved surface is polished equally. Do not remove more than .005" from the left or right bolt lug guideway surfaces.

Hone Receiver's Flat Bottom Bolt Lug Guideway Surface

This surface is usually polished to some extent in steps 1-3 above. If the surfaces are still pitted or rough, continue as follows.

4. Install new #400 sandcloth on the guideway polisher.
5. Keep the sandcloth wet with oil or solvent. Hone one side at a time, keeping the polishing head flat against the bottom lug guideway. Don't remove more than .005" from the flat guideway surfaces.
6. When the lug guideways are finished, the round bolt body guideways can be lightly polished with #400 sandcloth on a mandrel. Do not undersize these surfaces. See caution in figure 202.

Polish Exterior of Receiver

The receiver is polished before reheat treating so that the case hardened surface is not sanded or buffed through afterward. Prepare exterior surfaces as you would wish them to appear after bluing.

1. Hand detail the front ring and rear bridge to remove small scratches or blemishes with #400 sandcloth on a trued steel sanding block.
2. Lightly polish the above stockline receiver surfaces on an extra fine Scotchbrite flap wheel. Keep polishing lines parallel to impart a finely honed appearance. This metal finish is nearly ideal for rust bluing.
3. Utility grade receivers can be lightly sandblasted with fine silica sand before reheat treating.

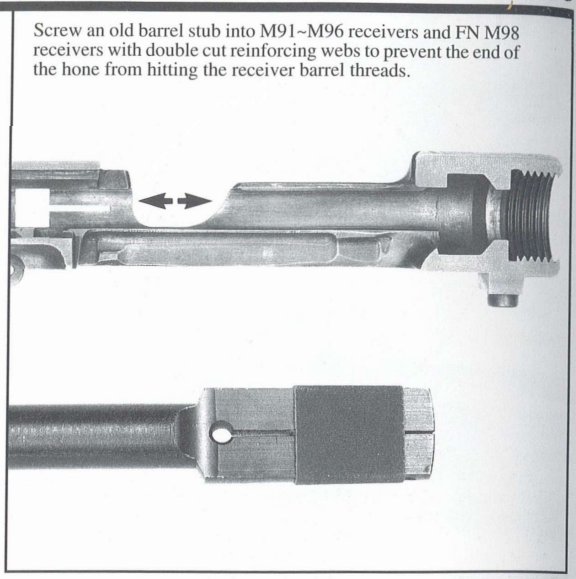


Figure 201- Shows the left bolt lug guideway in a sectioned M98 receiver. Guideways are honed at this time to remove rough areas and small pits before reheat treating the receiver. A Brownells guideway polisher is shown, below. Honing the guideways will usually remove what little is left of the original carburized surface. Case hardening after honing minimizes guideway wear and makes bolt travel smoother.

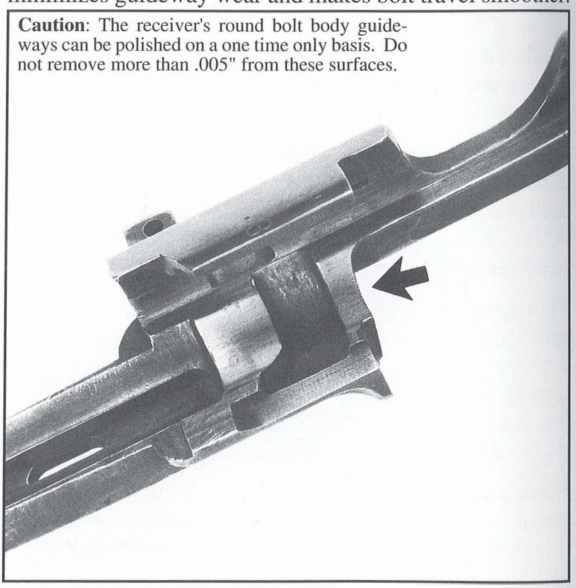
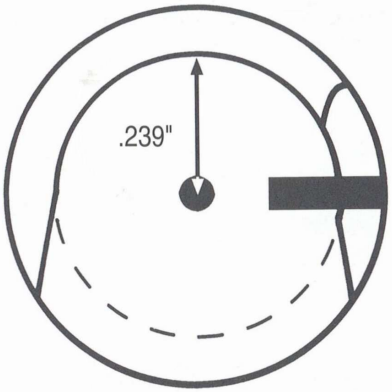


Figure 202- Shows the rear bolt guideway in a cutaway M98 receiver. This surface is lightly polished with #400 sandcloth wrapped on a round mandrel before the receiver is reheat treated. Do not remove more than .005" from the round guideway surfaces. Over polishing the front or rear bolt guideways permits the bolt body to ride lower in the receiver, which affects bolt face angle and firing pin port position.

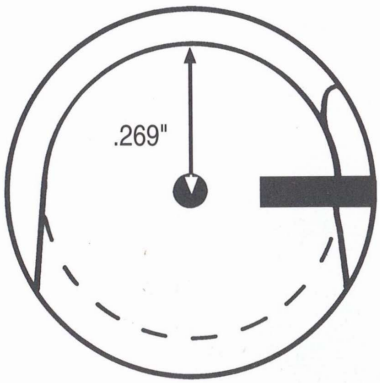


Standard .473" rimless cartridge rim diameter + .004" rim clearance = .477". .477÷2 =. 239" max. radius measured from the center of the firing pin port.

Bolt centering radius with 6.5 x 55mm Swedish Mauser cartridges is based on .480" rim diameter +.004" rim clearance or .242" when divided by 2.

Bolt centering radius with 7.65 x53mm Mauser cartridges is based on .474" rim diameter + .004" rim clearance, or .239" when divided by 2.

Figure 203- Illustration shows a shell head recess for a standard .473" dia. rimless cartridge in a Mauser M98 bolt. The bolt centering radius, at the top of the shell head recess, rides the cartridge rim and helps to align the bolt as the bolt locks. The .239" centering radius given is based on .473" rim diameter +.004" rim clearance, as discussed above.



Bolt centering radius with standard belted magnum cartridges is based on .532" rim diameter + .006" rim clearance or .269" when divided by 2. Radius is measured from the center of the firing pin port.

Warning: Small ring Mauser actions were designed for lower pressure cartridges, only. Do not open small ring action bolt face recesses to receive belted cartridges.

Figure 204- Illustration shows a shell head recess in an M98 bolt that has been opened to accommodate the diameter of a standard belted magnum cartridge rim. The bolt centering radius, shown above, is increased to .269" to align the bolt as the bolt locks. The .269" centering radius is based on .532" rim diameter +.006" rim clearance, as indicated above.

More About Cleaning and Opening Mauser Bolt Faces- Salts residue from corrosive military primer leakage absorbs moisture and causes corrosion around the firing pin port. Corrosion may look like a ring of small grey pits or a black stain. Fortunately, pitting is usually less than .003" deep and is easily removed by cutting .004"-.005" from the bolt face and then lapping the surface. See figures 205~208. Deeper bolt face pitting is sometimes found. In these cases, limit metal removal from the bolt face to .010" max.

Metal removed from the bolt face changes cartridge head position and exposes more of the case. A dangerous myth states that shell head enclosure is more important than case enclosure. This idea ignores the fact that cartridge case walls are considerably thinner than shell heads and need full chamber support.

About Bolt/Firing Pin Alignment- Ideally, in any bolt action rifle, the center of the firing pin port should coincide with the center of the primer in a chambered cartridge.

Several clearance/tolerance related factors conspire to position the bolt body and firing pin port on or off the centerline through the barrel and receiver. For best accuracy, the following factors must be controlled as much as possible:

1. Concentricity of the barrel and receiver threads and percentage of barrel thread fit. Barrel thread fit should be at least 85%.
2. Concentricity of the bore and the chamber inside the barrel.
3. Diameter of the chamber.
4. Bolt body clearance inside the receiver.
5. Firing pin port location inside the bolt body.
6. Location of bolt face bolt centering radius vs. the firing pin port.

Items 5 and 6 are usually remedied when refacing the bolt or opening the shell head recess. See figs. 203 and 204. Items 1, 2, and 3 are handled when receiver is rebarrelled. With all other items handled, item 4 is seldom a problem.

Lathe Clean Bolt Face

Warning: Bolt face surface cleaning and adjustment affects headspace directly, and is done only as a part of rebarrelling or barrel requalification followed by reaming and gauging chambers to the correct headspace.

1. Install firing pin port locator pin in the end of an .850" shank diameter bolt chucking mandrel and snug the mandrel in the bolt body.
2. Measure and note the distance to the bolt/cartridge centering radius. Half of locator pin diameter would equal the center of the firing pin port.
3. If the firing pin port is centered, measurement to the bolt/cartridge centering radius should be about as discussed in figures 203 and 204.
4. If the bolt handle is to be left on the bolt, install chucking mandrel and bolt in 3 jaw chuck. See figure 205.
5. Hand turn the lathe chuck and indicate the outside of the bolt as close to the bolt face as possible.
6. If bolt body runout on the chucking mandrel is .010" or less, and run out can be zeroed on the dial gauge with light hand pressure on the bolt body, adjust the steady rest to hold bolt body runout to .0005", or less. If runout is greater, or light hand pressure will not zero the gauge, trial and error position brass shims between the end of the bolt body and chucking mandrel shoulder to minimize runout.
7. Now check concentricity of the firing pin port by hand turning the lathe chuck slowly and indicating the firing pin port locator pin. The bolt facing tool can be used as a gauge to determine concentricity of the bolt face shell head recess.

Note: The firing pin port should be concentric with the outside of the bolt body. However, this is not always the case. If the firing pin port is within .005" of being concentric with the outside of the bolt, and the bolt centering radius is cut in agreement with the firing pin port, the bolt is well within tolerance requirements for most hunting rifles. Bolt/receiver clearance and bolt recess/cartridge head clearance will permit the bolt centering radius to align the firing pin port with the cartridge head.

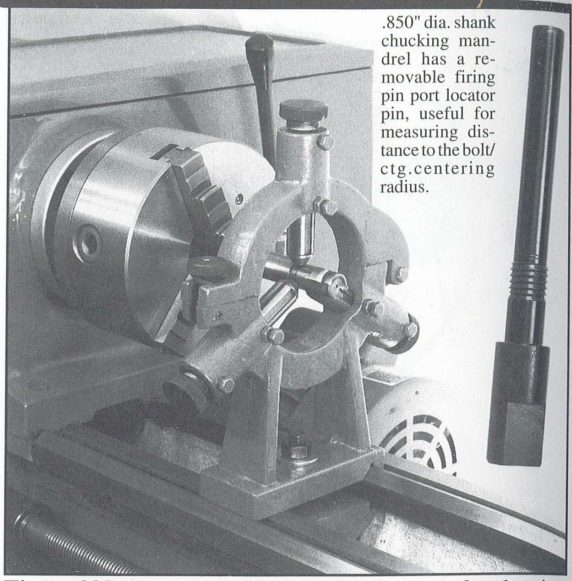


Figure 205- Shows traditional shop lathe setup for cleaning or enlarging bolt face recesses with the handle on the bolt. Buttress threaded bolt chucking mandrel, shown above, is installed in the bolt; CCW rotation keeps threads tight. Bolt runout on the mandrel is checked with a dial indicator. Shims may be needed between end of bolt and mandrel to minimize runout. Small runout can be adjusted out on the steady rest.

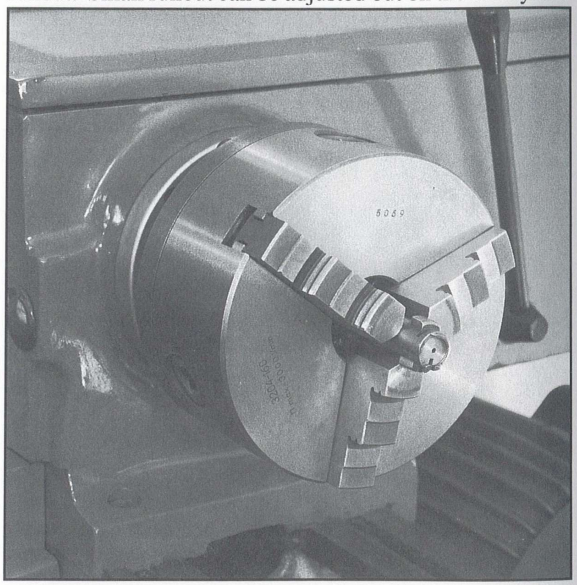
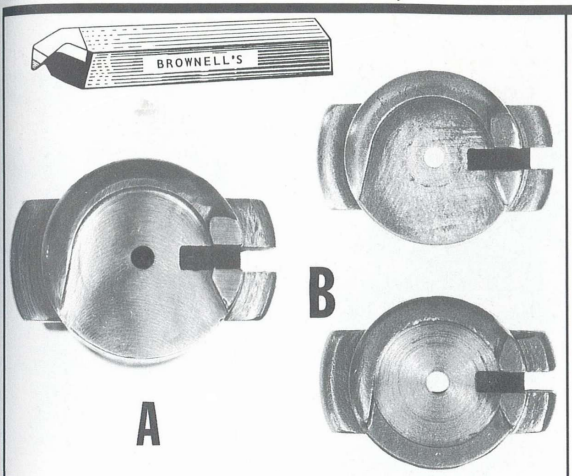
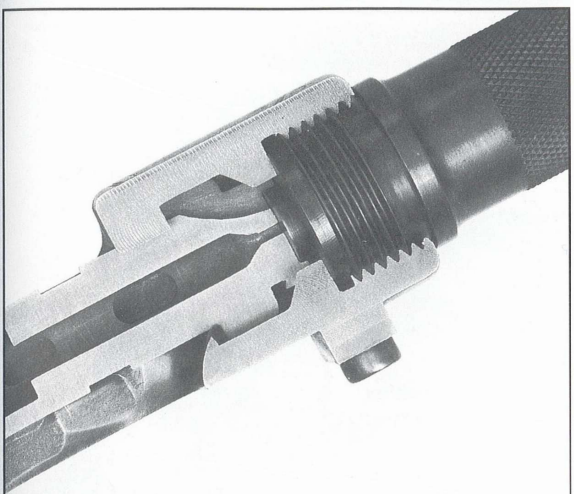


Figure 206- Shows an M98 bolt body set up in shop three jaw lathe chuck for cleaning or enlarging the bolt face recess. The direct chucking method is useful when lathe headstock/chuck runout is .0005" or less and bolt handles have been cut off, as shown in figure 212, in preparation for welding on a custom bolt handle. Combined bolt body/lathe chuck runout may require using the steady rest setup shown in figure 205.



Brownells bolt face tool is shown, above. Outside face ridges left after shallow bolt refacing need not be removed. Ridges that run .005" and higher can be removed by milling and lapping the lower bolt face.

Figure 207- Shows an M98 bolt face, at **A**, that cleaned up with only .004" machined from, and hand polished from, the bolt face surface. The bolt face, at **B**, had deeper pittingwhich cleaned up on the lathe at a depth of .008". The ridge left after truing the bolt face can be milled off with a carbide end mill and then levelled and blended into the bolt face with a lap.



The fine diamond abrasive head on the cartridge recess spot facing tool trues and polishes lathe cleaned bolt face surfaces. Shallow bolt face pits and ridges can be cleaned with this tool without lathe work.

Figure 208- Shows a cartridge recess spot facing tool, designed by author, installed in a cutaway M98 receiver. The diamond abrasive head trues and polishes the bolt face after lathe cutting. This tool also can be used to check for and true bolt faces that are not at 90° to receiver centerline. 90° check by coating bolt face with Dykem Blue, rotating the abrasive head, and inspecting polishing lines for full contact.

Lathe Clean Bolt Face, continued-
If the firing pin port isn't concentric, as discussed on page 170, or the bolt face shell head recess has been oversized, replace the bolt body.

8. Set carbide lathe tool so that the cutting face is at exactly 90° to bolt axis and the top cutting surface is even with a horizontal line through the center of the firing pin port. Position the tool so that, at beginning of the cut, the tip of the tool will almost be in contact with the bolt/cartridge centering radius ledge. Hand rotate the lathe chuck slowly to recheck setup before engaging the lathe transmission or turning on the lathe.

8. Set lathe at low speed. Begin cut with tool in light contact with the centering radius ledge and feed slowly toward center. Feed carefully to prevent overcutting or catching the tool. Clean and check the face and radius surfaces frequently to prevent overcutting. Machine the face just deep enough to clean the surface- but do not cut deeper than .010". Do not cut bolt/cartridge centering radius diameter larger than the limits given in figures 203 and 204.

An Alternate Facing Method
If the bolt face is only lightly pitted, or has shallow machine ridges, it can be trued and polished with a diamond abrasive spot facing tool as shown in figure 208. With this tool, bolt faces also can be checked for correct 90° agreement with receiver centerline.

About Ridges Left After Refacing-
Although M91~M98 bolts will feed cartridges with fairly high outside face ridges, feeding is smoother when ridges are not higher than .005" and the bolt is lightly 45° chamfered at the cartridge pickup edge.

There are several methods for removing outside bolt face ridges, including using an inside type toolpost grinder. However, the easiest way is discussed in figure 207.

Caution: Regardless of method used, the entire bolt face surface must be kept level and at 90° to the bolt axis. Lapping serves to further level and polish the bolt face surface. However, brass laps should be lathe trued and edge squared before use .

About Lock Time Reduction in Mauser M98 Actions-

Whether lock timing in any action is slow or fast is dependent on category of use. Lock timing in a standard M98 action is relatively slow when compared to later action designs. I would agree that M98 lock timing is somewhat slow for varmint shooting and too slow for long range target shooting. M98 lock timing, however, is more than fast enough for short to medium range (50-350 yards) medium and big game hunting rifles.

M98 Speed Lock Systems

The simplest method I have seen for quickening M98 lock timing is used in the speed lock system found on factory Mark X M98 Mauser actions. See figures 209 and 210.

M98 bolt/cocking piece speed lock modifications based on the above idea have been used by a number of riflesmiths and can reduce lock timing by about 25 to 40%.

Warning: Only commercial M98 sporter type cocking pieces with unnotched sear engagement ledges should be used in speed lock conversions. Sear engagement ledges on military type cocking pieces with vee cut sear ledges are left too thin when milled in an attempt to duplicate the dimensions of a Mark X cocking piece. The thin bottom edge of the remaining sear engagement ledge is subject to breakage after rehardening. This could cause an accidental firing mechanism release. Modified std. military cocking pieces must be replaced for this reason.

Modified commercial cocking piece cocking ramp and sear engagement ledge surfaces must be hard enough to cock the bolt smoothly and wear correctly. Modified cocking pieces with soft or galled engagement surfaces should be reheat treated.

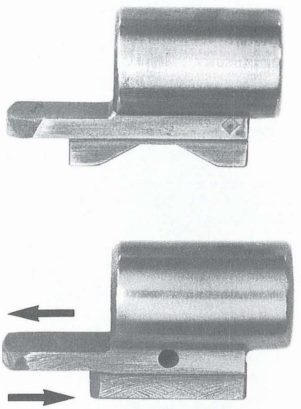
Warning 2: Mauser M91~M96 bolts and firing mechanisms should not be modified to cock-on-opening. These conversions cut through M91~M96 bolt assembly threads and weaken bolt bodies. See page 100.



Mark X speed lock update dimensions discussed on this page are based on measurements taken from parts specimens, and are included here for identification, only.

Figure 209- Shows a Mark X M98 Mauser speed lock type bolt in the cocked, open bolt position. The slightly longer speed lock cocking piece rests in an approx. .125" deep engagement notch in the bolt. This change allowed installation of a longer, more powerful firing pin spring. The rear bolt sleeve cut, see arrow, permits cocking piece installation and removal when a longer firing pin spring is used.

Mark X speed lock update dimensions discussed on this page are based on measurements taken from parts specimens, and are included here for identification, only.



The Mark X speed lock cocking piece cocking ramp extension measures about .010" to .115" longer than std. Mark X speed lock cocking piece sear engagement ledges are positioned approx. .075"-.080" to the rear.

Figure 210- Shows a standard military M98 cocking piece, at top. A Mark X M98 speed lock type cocking piece is shown below for comparison. Cocking ramp and sear engagement differences are measured from a reference line across the fronts of the cocking piece firing pin installation sleeves. With this design modification, firing pin travel is reduced about 25% to approx. .375".

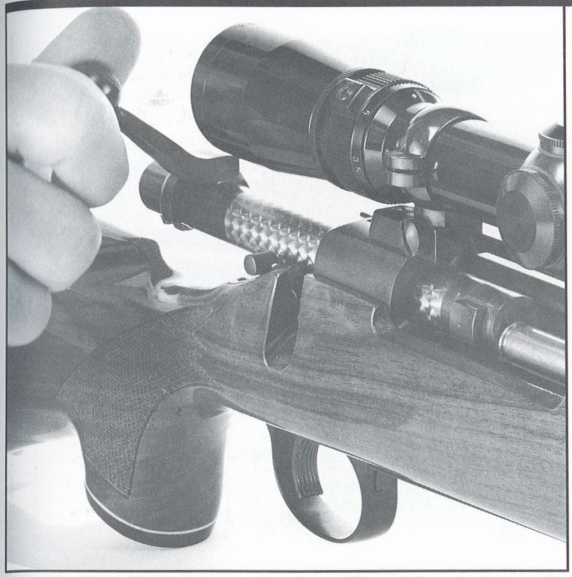


Figure 211- Shows a production rifle with a bolt handle contour that easily clears the lowest point on the subjective end of a scope mounted at medium height. Bolt handle contour, thickness, and bolt shank length interact to determine the final height of the scope clearance contour. When clearance with a low mounted scope is critical, the bolt handle must be thinner and/or the bolt shank shorter.

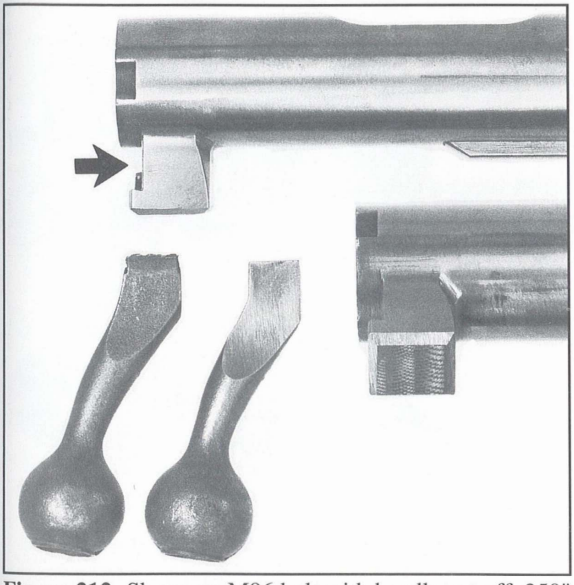


Figure 212- Shows an M96 bolt with handle cut off .350" from the bolt body. If the shank is cut shorter, the bolt stop, see arrow, is too easily damaged during welding. M98 bolt shanks can be cut shorter for scope clearance. Before welding, bevel the bolt shank and handle for greater weld penetration. The receiver may require clearance notching to permit the bolt to close, depending on shank length and handle contour.

Welding On Bolt Handles vs. Forging Bolt Handles

Custom metalsmiths usually prefer to weld on custom bolt handles rather than forging original bolt handles lower for scope clearance. There are two important reasons for this: bolt handle forging usually requires more heat than should be used (and scale removal afterward) and custom bolt handles almost always look better.

Even in instances where the original bolt handle is to be used, I would suggest cutting it off with a hacksaw, and then forging, shaping, and contouring the handle and welding it back on. The reason, again, is that much less heat is required for welding than forging.

Note: Bolt bodies must be reheat treated after the completion of bolt work, including the welding on of custom bolt handles. To prevent surface scaling and the additional exterior surface polishing that would result, install a heat sink in the bolt and coat the exterior with a scale control compound before welding.

About Custom Bolt Handles-

Quite a number of types and shapes of custom bolt handles are available. Custom bolt handles are contoured primarily to clear scopes as bolts are opened and cycled. Final shaping, including sweeping the handle back, is largely a matter of aesthetic design and personal taste.

About Bolt Handle Dimensions

Stock comb height and scope height must be correct for the rifle owner. These dimensions, once set, must be considered fixed. With scope height given, bolt handle height under the scope is limited.

Bolt body shank length, bolt handle thickness, and the clearance contour in the bolt handle combine to determine final bolt handle height.

Careful thinning and shaping of the scope clearance contour in the upper bolt handle is needed to enable a bolt handle to clear the larger diameter subjective end of most scopes. Remounting a scope higher because the bolt handle won't clear the scope-

Bolt Handles, Continued-
is unprofessional.

Shape and Prepare Custom Bolt Handle for Welding

1. Determine the amount of bolt handle backsweep required and secure the bolt handle shank between smooth vise jaws.
2. Heat the handle to cherry red with a neutral oxyacetylene flame, centering heat in the intended bend area. Move the torch, advancing heat as needed, and slowly bend the handle shank to the desired backsweep.
3. Place the shaped handle against the bolt body and visually check sweep angle. If shape is acceptable, allow the handle to air cool and proceed to the next step.
4. Then, determine handle shank length needed. Cut off excess handle shank material with a hacksaw.
5. Position the bolt body in the receiver with the bolt shank stub facing up. Then, place the cut off bolt handle shank in desired position on the bolt shank stub and measure maximum permissible height for scope body clearance.
6. Now, rotate the bolt body so that the bolt shank stub is at approx. 45°. Recheck with the handle in the proposed welded position to make sure that the top corner of the handle will clear the scope as the bolt is opened.
7. If too tall or a thinner appearance is desired, grind the top 1/3 of the bolt handle shank to desired scope clearance contour and recheck, as in #5 and 6 above.
8. Then, vee grind the bolt handle shank and the bolt shank stub weld joint edges for better weld penetration. See vee ground bolt shank stubs in figure 212.
9. Arc tack the underside of the handle to the bolt shank stub and recheck for correct clearance and appearance.

Necessary adjustments should be made at this time.

Weld Custom Handle on Bolt Body

Best methods are:

A. MIG weld or standard arc weld with mild steel rod.

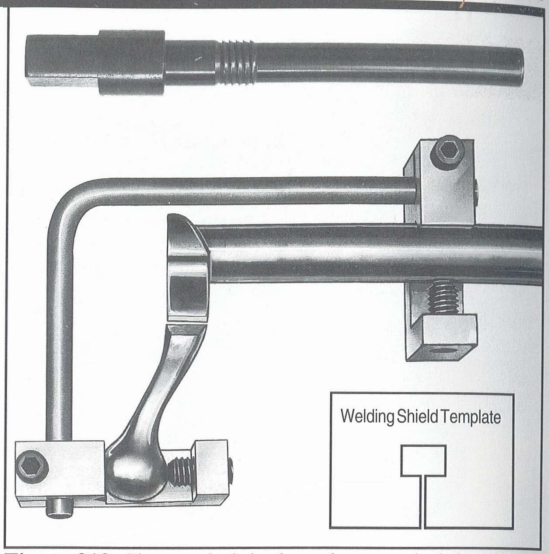


Figure 213- Shows a bolt body and custom bolt handle set up in a **Brownells bolt welding jig**. The bolt heat sink, shown at top, is installed in the bolt body before welding. Heat control paste is placed on the exterior and lug end of the bolt to dissipate heat and protect the surface. A soft copper bolt body protector formed around the bolt handle shields the bolt body during arc welding, see template illustration above.



Figure 214- Shows an M98 bolt with custom long sweep bolt handle welded on. Weld beads have been filed and blended in. If desired, the scope clearance contour can be ground further and thinned at this time for improved appearance or additional scope clearance. Bolt handles can be arc tacked on the underside and checked in the receiver before final welding.

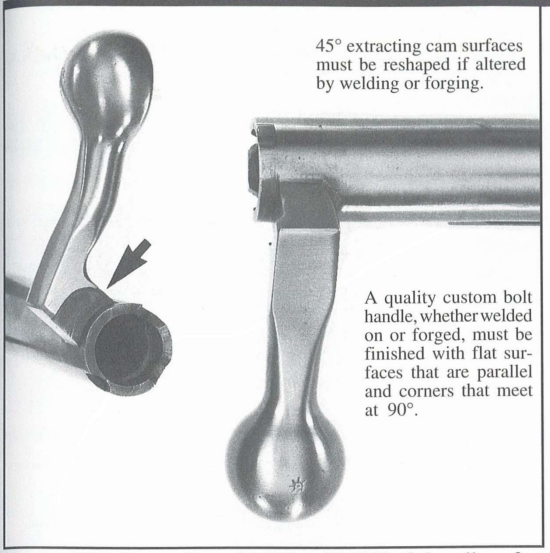


Figure 215- Shows forged M95 and M96 bolt handles after formed contours have been filed, blended in with a medium India stone, and prepolished with #320 followed by #400 sandcloth wrapped on a flat file. Round surfaces are prepolished shoeshine style with narrow strips of #320 and #400 sandcloth. The bolt stop surface, see arrow above, must not be damaged in the forging process.

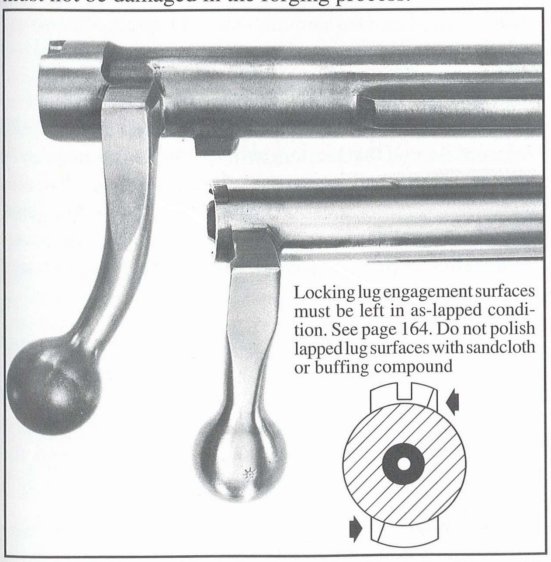


Figure 216- Shows bolt handles after hand detailing with sandcloth and polishing with #400 and #500 compound on medium and soft felt wheels. **Warning**: Do not polish the bolt face or bolt engagement surfaces on the locking lugs. Removing metal from the locking lug surfaces can cause unequal lug engagement and also affects headspace

Bolt Handles, Continued-

B. Gas weld with mild steel or 3 1/2% nickel rod and a neutral flame. 3 1/2% nickel rod is available from Brownells, Inc.

1. Detail clean the weld area and vee slots with trichloroethane and a clean wire brush.
2. Install welding heat sink in the bolt body and place the bolt body and bolt handle in the welding jig. See figure 213.
3. Wipe the bolt body, bolt face, and lugs with a liberal amount of heat paste.

Caution: Welding heat must be controlled regardless of the welding method used. Even though bolt bodies are reheat treated after bolt work is completed, do not permit the bolt face or bolt lugs to heat during welding.

4. Weld on the handle, controlling heat so that the vee slots are fully filled and the weld bead is slightly above the surfaces on either side. Do not carry so much heat that the edges of the weld bead visibly pocket or crater.
5. Allow the bolt body to air cool. Then, wire brush welds and closely inspect for any irregularity that would be visible after weld beads have been filed. Fill weld as needed.
6. Hand detail and polish the bolt, as discussed in figures 215 and 216.

Note: Bolt handles are one of the first details looked at when custom metal work is examined. Needless to say, final appearance is important. The flat sides should be parallel. The welded top surface should be perfectly flat and at 90° to both sides. The curved scope clearance contour should be shaped as if machined and kept flat when polished. The finished scope clearance contour should be parallel with the bolt body. Sharp 90° outside corners can be lightly 45° chamfered or lightly radiused when buffed.

Before Beginning Barrel Work-

Barrel replacement and custom barrel fitting are the most often asked for riflesmithing jobs that require precision machine work. Although riflesmiths do not have to be professional machinists, skill and experience with lathe work is needed to fit and chamber barrels correctly.

Under the broad heading of ***gunsmithing*** there are many separate specialties- and probably more than a single person could span. If you are primarily a repair gunsmith, stockmaker, engraver, or metal finisher, etc., and do not have lathe experience or a lathe in your shop, I would suggest working with other riflesmiths and metalsmiths whose specialties compliment your own. This particularly applies to precision machine work. If your shop equipment is limited, or machine work is not your specialty, subcontract barrel work to a riflesmith or barrel specialist who has the equipment, experience, and reputation to do the job well and to your satisfaction.

On the other hand, if you have a lathe, or lathes, in your shop, and lathe experience, barrel work can be a rewarding and profitable part of your business.

After custom stock work, barrel replacement and custom barrel work are the second highest cost items in rifle building. With this in mind, many market conscious riflesmiths offer customers a two tier approach to custom barrel installation:

1. Installation of premium barrel blanks. These are suggested for expensive premium quality varmint, target, and custom sporting rifles. These barrels are individually special ordered for customers in either chrome molybdenum or stainless steel and in the desired caliber, twist rate, and profile.

2. Installation of less costly factory contoured, prethreaded and chambered barrels. These are suggested for hunting rifles and general purpose sporting rifles. An inventory of prethreaded barrels in popular calibers is stocked and selected from by the riflesmith.

Considering today's high material and labor costs, this is a wise and practical approach. A riflesmith and old friend who specializes in barrel work commented that hunters in his part of the country want "carry and shoot" rifles, not heavier profile tack driving varmint and target rifles. He also commented that, if he installed only premium blanks, he would lose 90% of his business. Machining and fitting unthreaded barrel blanks is labor intensive and more expensive than many hunters and shooters can afford. It is also logical that premium quality barrel blanks should be used on higher ticket custom rifles.

Although, to some, prethreaded barrels might seem second quality when suggested as an alternative to premium barrel blanks (largely because of the *drill a hole in it- run a broach through it* grade barrels made by some manufacturers in the past), the fact is that quality prethreaded barrels made by name manufacturers are usually excellent. When a quality prethreaded barrel is carefully fit and correctly installed on a well prepared Mauser receiver, performance on target will exceed the capability of any off the shelf hunting rifle, in virtually every case. See barrel selection on page 154.

The trick, however, is to prepare each receiver with care and final fit, install, and finish ream chambers in prethreaded barrels with the same precision as would be used with a more expensive premium blank.

Today, more prethreaded sporter barrels are sold than any other type. Military replacement barrels have always been prethreaded. For these and reasons above, barrel work in this manual is discussed primarily on the basis of fitting and installing prethreaded barrels. Supplemental data on threading and fitting contoured barrel blanks is also included.

About Machining and Fitting Replacement Barrels-

Only rebarrelling data for Mauser M91~M98 actions is discussed in this section. Rebarelling other Mauser style actions and design spinoffs is not discussed in this manual. Consult applicable barrel installation and machining data for the specific action or rifle model in question.

Although the subjects of machining errors and concentricity problems overlap, most of the problems associated with barrel fitting and installation divide into these two basic categories:

Machining Dimension Problems- are usually caused by lathe tooling not ground or set up correctly (barrel shoulders are not cut at 90°, etc.); use of inaccurate measuring tools (barrel shoulders are cut short); floating chamber reamer holders are not used (oversized chambers); lathe centering buttons and dial indicators are not used (causes various misdimension problems). Basic measurement and setup error elimination procedure is:

1. Measure receiver barrel threads vertically and horizontally with an inside thread caliper and check with a micrometer.

2. Check receiver barrel thread angle to determine if the threads are still the original 55° Whitworth standard, or have been chased. See note 2 below.

3. Measure individual receivers with a depth micrometer to determine the actual barrel thread extension length needed to correctly fit the receiver.

4. Measure receiver barrel torque shoulders with a dial caliper to determine correct torque shoulder diameter.

5. Set up lathe tooling for face cuts at 90° to the chuck . Set up for thread cutting with a center gauge.

Note: Mauser actions are found with slightly different major and minor receiver barrel thread diameters and with threads that are slightly tapered or slightly oval. Slight receiver ring ovalling can occur in the heat treating and reheat treating process. Receiver ring and receiver thread ovalling can increase, to some degree, with proof firing. For this reason, factory original and factory replacement barrels were made with 85% threads. Most downstream military replacement barrels and sporter barrels made by Mauser affiliates and other manufacturers were also manufactured with 85%, or slightly larger, threads. Some M98 variations have nonstandard receiver ring lengths and diameters and different barrel thread extension requirements. Receiver preparation for rebarrelling, discussed earlier, also affects final barrel thread extension length. For this reason, all Mauser receivers must be individually measured and barrels adjusted to correct thread extension length.

Note 2: Standard Mauser 55° Whitworth receiver barrel threads that have been chased with a U.S. standard 60° vee thread tap to better accommodate U.S. 60° thread sporter barrels should not be rebarrelled with original military or other European barrels with 55° Whitworth standard threads.

Concentricity Problems- are typically caused by lathe chuck/headstock runout and headstock/tailstock misalignment. Lathe concentricity problems are compounded by the lathe operator not checking runout; making incorrect setups, including not using a steady rest; and not checking and adjusting barrel exterior concentricity at the muzzle end and at the cylindrical shank section just ahead of the thread extension before making muzzle crown, thread, or chamber adjustments. Basic runout elimination procedure is:

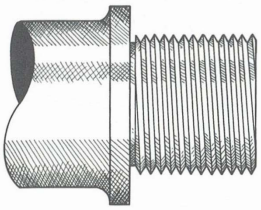
1. Make sure lathe bed is level and that the headstock and tailstock are aligned before machining.

2. Check headstock/lathe chuck runout so that a decision can be made as to whether barrel torque shoulders can be machined with the barrel installed directly in the three jaw chuck or whether a steady rest must be used to control runout.

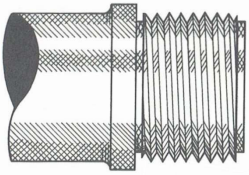
3. When needed, use steady rest setups and a dial indicator to reduce runout to an acceptable minimum.

4. Use a floating reamer holder to prevent chamber oversizing caused by runout.

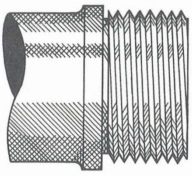
Military barrel torque shoulder diameters can vary somewhat with individual contract order specifications. Commercial sporter barrel torque shoulders also vary in diameter and are almost always larger. Standard barrel thread extension lengths and major barrel thread diameters, shown on page 178, help identify Mauser M91~M98 barrel threads.



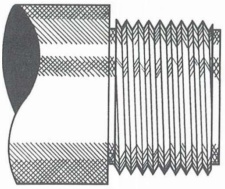
M91 Mauser
(Argentine & others)
Small ring threads
.980" dia. x .625" L
(See note 2) 12TPI
55° Whitworth thds.
U.S. mfg. barrels have
60° U.S. std. threads



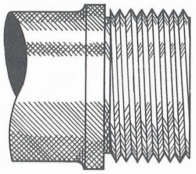
M98 Military Mauser
Large ring threads
.110" dia. x .625" L
(See note 1) 12TPI
55° Whitworth thds.
U.S. mfg. barrels have
60° U. S. std. threads



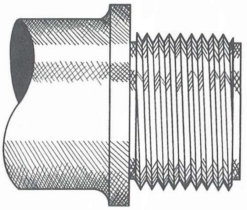
M93~M95 Mauser
Small ring threads
.980" dia. x .645" L
(See note 1) 12TPI
55° Whitworth thds.
U.S. mfg. barrels have
60° U.S. std. threads



M98 Comm. Mauser
Large ring threads
.110" dia. x .625" L
(See note 1) 12TPI
55° Whitworth thds.
U.S. mfg. barrels have
60° U.S. std. threads



M94/M96 Mauser
(Swedish)
Small ring threads
.980" dia. x .645" L
(See note 1) 12TPI
55° Whitworth thds.
U.S. mfg. barrels have
60° U.S. std. threads



G33/40 Mauser
(And similar models)
Small ring M98 threads
.980" dia. x .625" L
(See note 1) 12TPI
55° Whitworth thds.
U.S. mfg. barrels have
60° U.S. std. threads

Drawings are not to scale.

Figure 217- Illustrations show standard military M91~M98 barrel thread extension lengths and major thread diameters. Although there are exceptions, most military barrel torque shoulder diameters typically measure from 1.100" to 1.115".

Caution: Mauser military and commercial prethreaded replacement barrels were manufactured with standard blueprint dimension barrel thread extensions, as shown above. These illustrations and dimensions are furnished here for barrel/receiver identification and reference. Exact measurements taken from the receiver that is to be rebarrelled must be used to determine required barrel thread diameter, torque shoulder diameter, and barrel thread extension length.

Mauser M91~M98 barrel threads are non-metric Whitworth standard 55° threads. The standard major barrel thread diameters, given above, may be too large (or, in rare cases, too small) to fit barrel threads in some Mauser receivers. Large diameter barrel threads will require adjustment in order to fit correctly. Barrels of any of the above types with a given thread diameter may be loose in some receivers and tight in others. For this reason, prethreaded barrels should be selected for 85% or better thread fit in the receiver that is to be rebarrelled. Barrel thread diameter should then be adjusted so that the barrel will just screw in by hand with a light drag fit.

Receivers with oversized threads should be rebarrelled with a custom lathe threaded barrel blank to ensure correct fit.

Although exceptions are found, military barrel torque shoulders usually measure in the 1.100" to 1.115" diameter range. M91~M96 commercial sporter barrels should have shoulder diameters of 1.140" or larger. Commercial sporter barrel shoulder diameters for large and small ring M98 models should be 1.200" or larger.

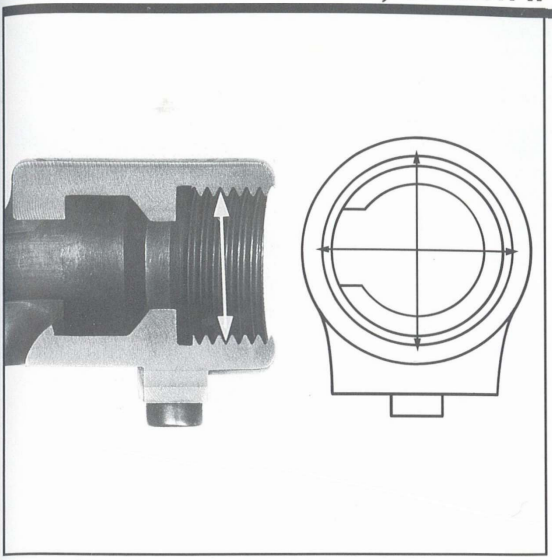
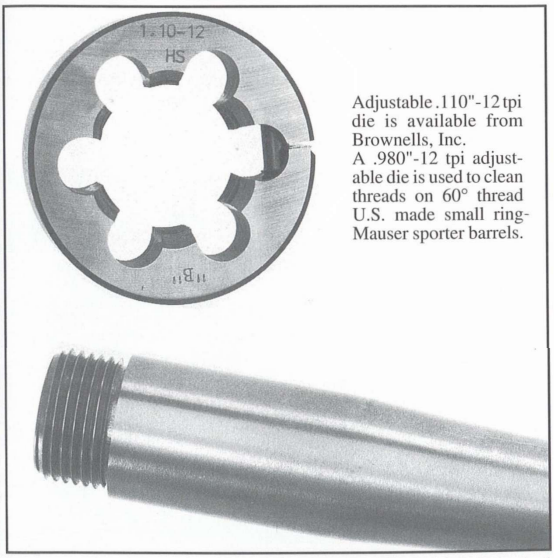


Figure 218- Shows barrel threads in a half sectioned M98 receiver. Receiver barrel thread diameter must be measured in both directions as shown in the illustration, at right, to check for slightly irregular or out of round threads. Receiver threads can be measured for rebarrelling purposes with an inside thread caliper. The caliper extension is then checked with a standard micrometer.



Adjustable .110"-12 tpi die is available from Brownells, Inc. A .980"-12 tpi adjustable die is used to clean threads on 60° thread U.S. made small ring-Mauser sporter barrels.

Figure 219- Shows the thread extension on a prethreaded U.S. made M98 sporter barrel after threads have been cleaned with an adjustable .110"-12 tpi die. The adjustable die, shown separately above, is set at existing thread diameter to remove nicks or burrs on either prethreaded or lathe threaded barrels. The die can be readjusted to reduce thread diameter on slightly thread tight barrels.

Receiver/Barrel Thread Fit

Mauser M91~M98 barrel and receiver thread tolerances vary somwhat with production run and manufacturer. This creates downstream plus and minus differences in receiver and barrel threads. Threads on prethreaded military barrels and commercial sporter barrels also vary somewhat in diameter. For this reason, prethreaded replacement barrels must be hand selected for best thread fit in the Mauser receiver that is to be rebarrelled. Receiver thread diameter can be measured with an inside thread caliper. See figure 218.

Because barrel threads are sized to 85% fit, U.S. barrels with 60° standard U.S. vee threads can be screwed into Mauser receivers with 55° Whitworth threads.

The effect of this slight mismatch is that 60° U.S. threads tend to be too loose when major barrel thread diameter is slightly small and too tight when major barrel thread diameter is correct.

I would suggest either of the following as a solution:

1. Maintain the 55° thread match. Use 55° threaded barrels in receivers with original 55° threads. Lathe cut custom barrel threads at 55°.
2. When a prethreaded sporter barrel with standard U.S. 60° threads is to be installed, and receiver roundness permits, chase 55° receiver barrel threads with a U.S. standard 60° tap. Then, adjust barrel threads to a light drag fit.

Caution: Slightly oval, slightly tapered, or slightly undersized case hardened receiver threads can bind or seize the tap. If this begins to happpen when chasing threads, back out the tap before it binds or sticks and damages either the receiver or the tap. In this case, the barrel and receiver threads can be lapped to fit with super fine abrasive flour.

Clean Barrel Threads

U.S. 60° replacement barrel threads can be cleaned and adjusted with .110"-12 tpi or .980"-12 tpi adjustable dies. See figure 219.

Measure Receiver for Barrel Thread Extension Length

M98 Receivers-

Before measuring an M98 receiver for barrel thread extension length, the primary and secondary barrel torque shoulders should be trued as discussed in figures 190, 193, 196, and 197.

1. Measure the distance from the secondary torque shoulder at the front of the receiver to the primary torque shoulder located on the front of the receiver's internal reinforcing web with a depth micrometer.
2. To make sure that torque shoulders are parallel and are both at 90° to receiver centerline, measure distance again in a minimum of three, preferably four, separate locations. **Note**: A parallel difference of .001", or less, is suggested as maximum acceptable for short and medium range hunting rifles. Surface differences greater than .001" usually do not offset and equalize when a barrel/receiver combination is torqued. This can cause an uneven torque/stress load on the receiver. This condition may also cause uneven bolt lug engagement, in some cases. For this reason, I suggest truing and parallelling torque shoulders in M98 receivers before barrel installation.
3. Presuming that the primary and secondary torque shoulders are parallel, or within .001" of parallel, the distance measured between the two surfaces equals correct M98 barrel thread extension length.

M91~M96 Receivers-

M91~M96 receivers have only one barrel torque shoulder. This surface should be trued, as discussed in figures 191 and 197, before measuring the receiver for barrel thread extension length.

1. Measure the distance from the torque shoulder at the front of the receiver to the front of the top bolt lug with a depth micrometer.

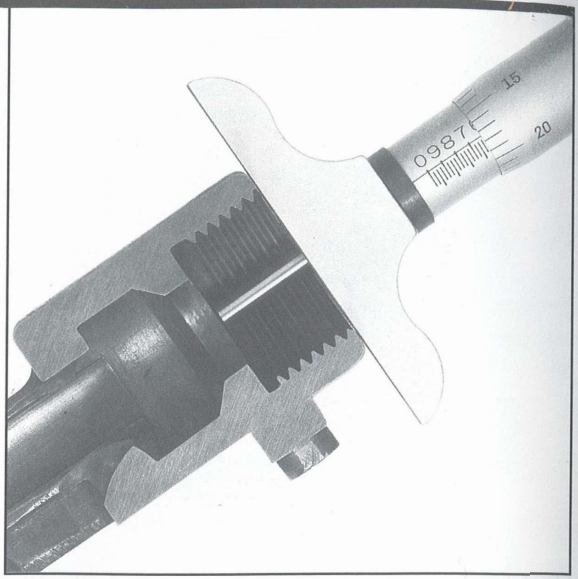
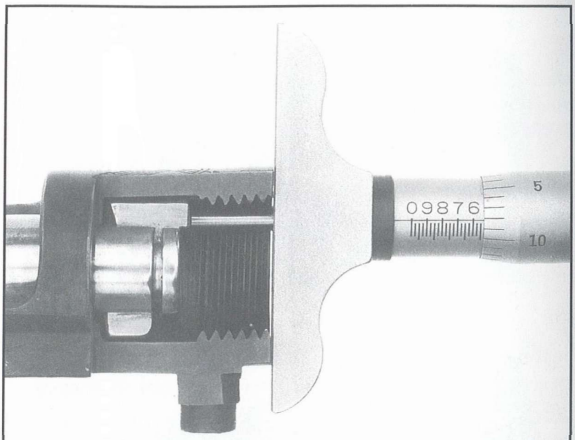


Figure 220- Shows the distance to the primary torque shoulder being measured in a half sectioned M98 receiver with a depth micrometer to determine correct barrel thread extension length. If the primary torque shoulder hasn't been trued, as discussed on page 163, the receiver must be measured in at least three places. Variation should be less than .001".



Note: Approx. .005" is deducted from actual top lug measurement in M91~M96 actions for bolt lug clearance. About .002" of this deduction is offset due to torque crush when the barrel is installed.

Note 2: M91 extractor backup pins or rear barrel faces may require clearancing before M91 barrels are torqued.

Figure 221- Shows distance being measured from the barrel torque shoulder at the front of a half sectioned M95 receiver to the front of the top bolt lug to determine correct barrel thread extension length. The bolt lugs must be in locked position and held in full contact with the receiver lugs for correct measurement.

Barrel thread extension length on most prethreaded Mauser sporter barrels runs approx. .625" to .650". In most receivers, small shoulder adjustments are usually needed to make a prethreaded sporter barrel fit. Greater adjustment is needed when receiver torque shoulders have been trued.

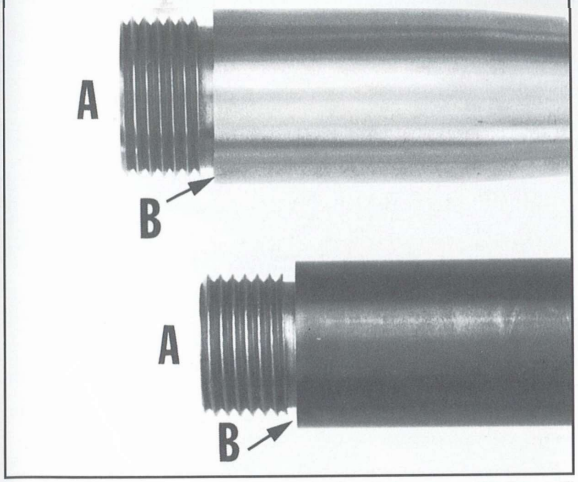


Figure 222- Shows prethreaded M98 large ring and small ring sporter barrels. The rear barrel face surfaces, shown at **A**, are adjusted on the lathe when the barrel thread extension is too long for the receiver. The torque shoulders, shown at **B**, are lathe adjusted when barrel thread extensions are too short for the receiver. See final fitting note in figure 234.

Before starting barrel work, check and adjust headstock/tailstock alignment with a dial indicator or micrometer and lathe centering buttons, shown at right. Then, check chuck/headstock runout. If runout is greater than .0005", use steady rest setups for crowning and chambering work.

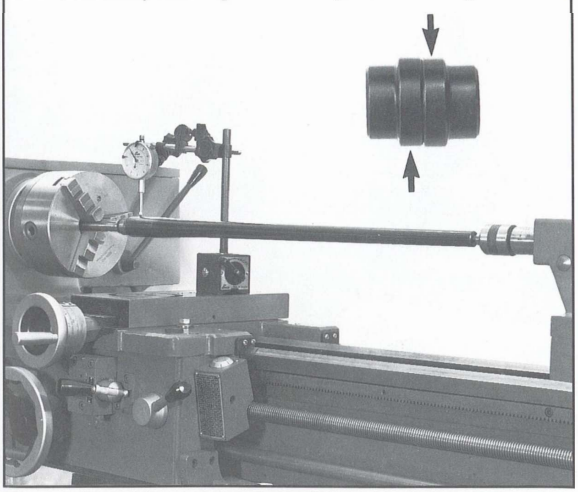


Figure 223- Shows a prethreaded sporter barrel set up on lathe between live and dead centers. The barrel is hand turned to runout check the cylindrical shank (just ahead of the thread extension) and O.D. at the muzzle end with a dial indicator. This is done before chucking the barrel in the lathe to adjust the rear face or torque shoulder. The shank and muzzle end must be concentric for accurate lathe setups.

M91~96 Thread Ext. Continued-

Note: Prevent false measurements by carefully holding M91~M96 bolts in fully locked position with both bolt lugs firmly and evenly engaged on receiver bolt lugs while thread extension measurement is made.

2. Subject to above requirements, the distance measured from the torque shoulder to the front of the top bolt lug, minus approx. .005" for bolt clearance, equals the correct barrel thread extension length.

Note: Thread rotation and torque crush typically interact to reduce the above .005" lug clearance by about .002". This usually leaves a net barrel face/lug clearance of approx. .003" after the barrel is torqued.

Adjust Thread Extension

When a barrel thread extension is long, the rear barrel face is shortened. If the thread extension is short, the barrel torque shoulder is adjusted.

There are several ways to adjust prethreaded barrel surfaces. I prefer the following:

1. Runout check the cylindrical shank portion of the barrel ahead of the thread extension. The shank must be concentric with the bore to chuck directly in the lathe. See figures 223 and 224.

2. If the shank has runout, true on lathe before installing in the chuck. Or, if requalifying a finished barrel, adjust torque shoulders using the steady rest setup in figure 232.

3. If the shank is concentric, install the barrel in 3 jaw lathe chuck as shown in fig. 224. Wrap shim stock around the cylindrical section of finished barrels to prevent marking. **Caution**: Only one ply of shim stock must be under each chuck jaw.

4. Set carbide lathe tool to 90° and carefully trim shoulder or rear barrel face to correct thread extension length. Length calculation should allow several thousandths for final truing/polishing of the barrel face.

5. Leave barrel in lathe and screw on receiver to check thread extension length. See figure 225.

Adjust Thread Extension, Continued-

6. Visually check the receiver and barrel torque shoulder joints with the receiver hand tightened on the barrel. The barrel is left chucked in the lathe for this check.

M98 barrel thread extension length must be exact. When barrel thread extension length is correct, the rear barrel face and the barrel torque shoulder will contact the receiver's primary and secondary torque shoulders at exactly the same time. Hand tight torque shoulders should meet with a zero clearance fit. M98 barrel secondary torque shoulders are clearanced .001"-.0015" before barrel installation. See figure 225. When hand tightened, torque shoulders on M91~M96 barrels should also meet receiver torque shoulders with a zero clearance fit. With M91~M96 receivers hand tight, the front of the top bolt lug (the lug that is cut for ejector arm clearance) must clear the rear barrel face by .005".

7. If the barrel thread extension is found to be slightly long or short, precision trim the rear barrel face or barrel torque shoulder until the thread extension fits the receiver correctly.

Note: When barrel thread extension length and barrel/receiver torque shoulder fit is correct, the torque surfaces will meet on time and the receiver will feel solid when it is only hand tight on the barrel. Correctly fit torque joints will appear as if already torqued when only hand tightened.

Measure Receiver/Bolt Body for Correct Chamber Depth and Headspace

Once the barrel thread extension has been correctly fit to match the receiver, the bolt body that was mated to the receiver previously can be installed to estimate headspace requirements and finished chamber depth. See figures 226 and 227.

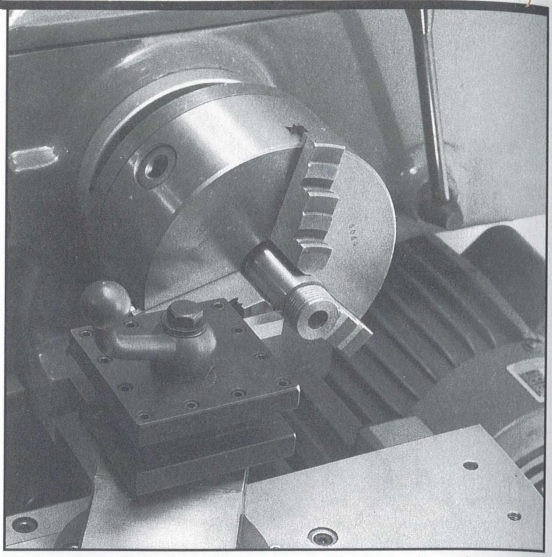
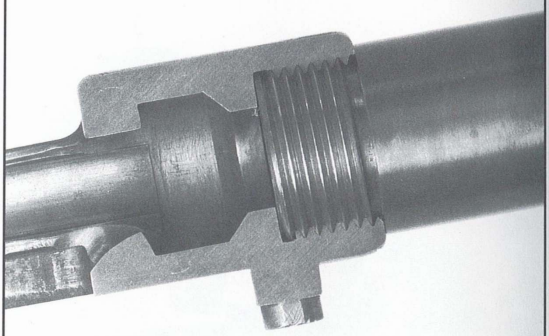


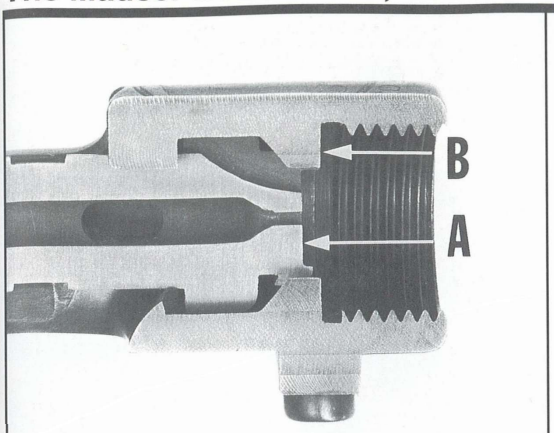
Figure 224- Shows the cylindrical shank portion of a sporter barrel installed in the lathe three jaw chuck after runout check and truing. Carbide shoulder/face adjusting lathe tool is set at 90° to trim the rear barrel face and/or torque shoulder to the correct barrel thread extension length. A spider clamp holds the barrel as it exits the back of the lathe headstock.

When hand tight, barrel/receiver torque shoulders must meet with a zero clearance fit. The barrel is left in the lathe setup shown in figure 224 for this check. Also see M98 barel final fitting in figure 234.



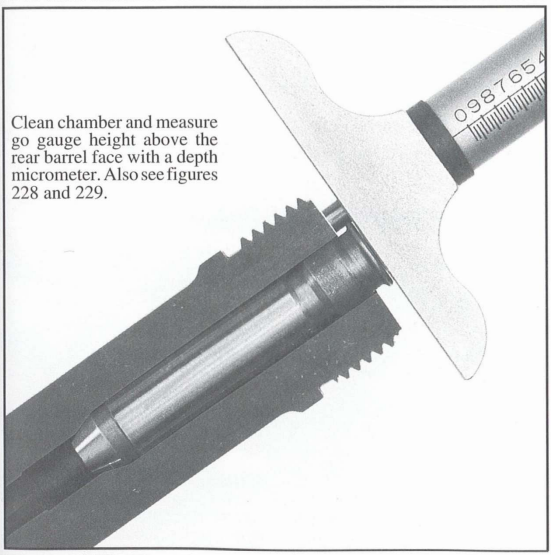
M91~M96 barrel thread extensions and torque shoulders are similarly fit. In these models, the rear barrel face is preadjusted so that the top bolt lug will clear the rear barrel face by .003" when the bolt is rotated to the locked position after the barrel has been torqued in the receiver.

Figure 225- Shows an M98 barrel thread extension being fit checked in a cutaway M98 receiver. When the barrel is hand tight, the barrel torque shoulder and rear barrel torque face must contact the primary and secondary receiver torque shoulders at exactly the same time. Barrel/receiver shoulder contact should feel 100% solid as rotation stops.



A depth micrometer is used to make the A and B measurements, above, that determine the distance between the bolt face and rear barrel face. The resulting figure is used as a reference for checking and estimating correct chamber depth in an untorqued barrel.

Figure 226- Shows bolt face/receiver measuring points used to check chamber depth in an untorqued barrel and estimate final depth and headspace after the barrel is torqued. Measure distances from the front of the receiver to the bolt face, at **A**, and the primary torque shoulder, at **B** (or top bolt lug in an M91~M96 action) with a depth micrometer. Subtract **B** from **A** to find distance from the bolt face to the rear barrel face.



Clean chamber and measure go gauge height above the rear barrel face with a depth micrometer. Also see figures 228 and 229.

Figure 227- Shows a go headspace gauge installed in a prechambered barrel. If go gauge height measures greater than the distance from the bolt face to the rear barrel face as found in figure 226, the chamber is short and must be reamed to the correct depth. If measurement is less, the chamber is long. Headspace would be excessive. Rifle chambers are finish reamed to just permit the bolt to close on a go gauge.

Measure Receiver/Bolt Body for Correct Chamber Depth and Headspace, Continued-

1. Hold the bolt in the receiver in the locked position with both locking lugs firmly engaged.
2. Measure the distance from the trued torque shoulder at the front of the receiver to the bolt face.
3. Then measure the distance, in M98 receivers, between the primary and secondary torque shoulders and subtract this measurement from #2, above. See figure 226.
4. Mated M91~M96 bolt/receiver assemblies are measured in the same way as an M98, except that distance B is measured from the torque shoulder at the front of the receiver to the front of the top bolt lug in the locked position. See figure 226.

Note: It becomes particularly apparent, at this point, that torque shoulders and bolt faces must be at 90° to receiver/barrel centerline. If these surfaces are not parallel and at 90° to centerline, headspace can't be accurately gauged. Headspace, in fact, would be different when referenced to any point on the bolt face. If the bolt face surface is not at 90°, cartridge heads will fire form on an angle. For this reason, I suggest measuring the distance from the torque shoulder at the front of the receiver to the bolt face in at least three locations. Also see bolt face cleaning and truing on page 171.

5. Detail clean the chamber and install a matching go headspace gauge. Carefully measure distance from the rear barrel face to the back of the go headspace gauge as shown in fig. 227. Note the measurement. The amount that this measurement exceeds the distance from the bolt face to the rear barrel face equals the approximate amount a short chamber must be reamed forward to headspace correctly.
6. Short chambers are then reamed and final adjusted as discussed in figures 228, 229, and on pages184 and 185.

Lathe Finish Ream Chamber

Most barrel specialists fully finish ream chambers while barrels are still in the lathe. This procedure requires exact measurements and accurate allowances for final thread rotation/ torque crush (usually .0015"-.002"). A large dial indicator (.001" graduations with 1 revolution =.100"), a tailstock mounted floating reamer holder, and a very careful hand are needed to finish ream chambers on a lathe. When chamber is within about .020" of final depth, set up and zero dial indicator to measure finish reamer cutting depth. To prevent over reaming, frequently detail clean the chamber and check depth with a go headspace gauge and depth micrometer, as shown in figure 227, as correct chamber depth is approached. Set lathe at 60 rpm before reaming. Reamer feed rate can be critical. If rate is too fast, the reamer may catch and chatter; if too slow, cutting edges will dull. A finish reamer feed rate of .002"-.003"/second is fairly standard but depends on the reamer, reamer sharpness, barrel steel hardness, and the cutting lubricant used.

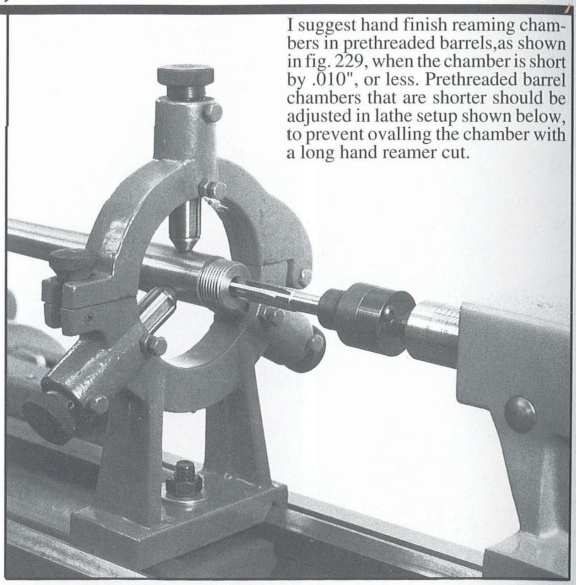
Remove and clean the reamer at about each .050" increase in chamber depth. Flush and blow chips from the barrel. Make sure reamer, reamer pilot, and bore are clean before repositioning.

Caution: Because of the error potential associated with full depth lathe reaming, I would suggest finish reaming chambers on the lathe to within approx. .005" of final depth and then hand finish reaming the chamber to correct minimum headspace after the barrel has been installed and torqued. If chambers are over reamed, barrels will have to be requalified or replaced.

Hand Finish Ream Chamber

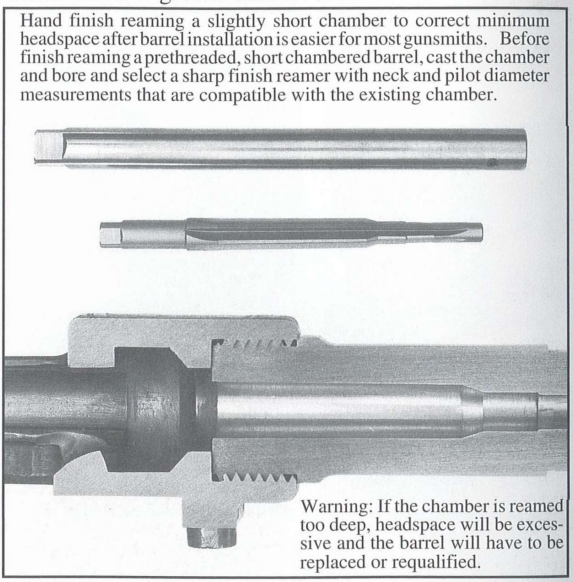
Chamber finish reamers must be sharp, of correct diameter, and in new condition without edge nicks or other damage.

1. Set up barrelled receiver in bench vise with barrel pointing straight down. Install reamer in T handle or wheel handle and lubricate the bore and finish reamer with cutting oil.
2. Carefully rotate reamer in chamber.



I suggest hand finish reaming chambers in prethreaded barrels,as shown in fig. 229, when the chamber is short by .010", or less. Prethreaded barrel chambers that are shorter should be adjusted in lathe setup shown below, to prevent ovalling the chamber with a long hand reamer cut.

Figure 228- Shows finish reaming a rifle barrel chamber in a lathe steady rest setup. When barrels are concentic, runout can be reduced to virtually zero by using a steady rest. Use this setup when rough and finish reaming chambers in barrel blanks and when finish reaming short chambers in prethreaded barrels if lathe vibration is excessive and/or headstock/ chuck runout is greater than .0005"



Hand finish reaming a slightly short chamber to correct minimum headspace after barrel installation is easier for most gunsmiths. Before finish reaming a prethreaded, short chambered barrel, cast the chamber and bore and select a sharp finish reamer with neck and pilot diameter measurements that are compatible with the existing chamber.

Warning: If the chamber is reamed too deep, headspace will be excessive and the barrel will have to be replaced or requalified.

Figure 229- Shows a short chambered barrel torqued in a cutaway M98 receiver. Chambers in prethreaded barrels that are short by .010" or less can be finish reamed by hand with a chamber finishing reamer installed on a T handle or wheel handle. Use light even pressure and plenty of oil when finish reaming by hand. Clean chambers and gauge check headspace frequently to prevent reaming too deep.

Warning: Brass cartridge case walls must be fully supported. The chamber mouth chamfer, in barrels chambered for rimless cartridges, must not be cut deeper than the extractor bevel on the cartridge case the barrel is chambered for.

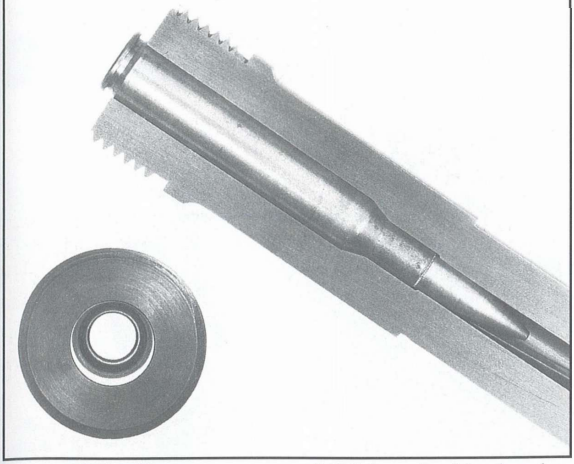


Figure 230- Shows a cutaway M98 barrel with chamber finish reamed to correct depth and headspace. After chambering, the chamber mouth is 45° chamfered and polished to prevent catching or scarring rounds as they are fed from the magazine. A dummy round is installed in the chamber to make sure the chamber fully supports the brass cartridge case to the edge of the case extractor bevel.

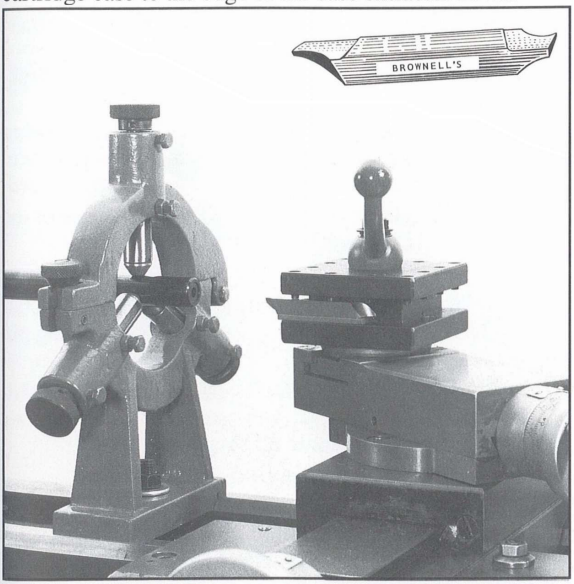


Figure 231- Shows barrel in steady rest setup on lathe for muzzle crowning. The thread extension is threaded into a delrin insert and installed in the three jaw chuck. The muzzle end is indicated and centered in steady rest before crowning. Barrel O.D. must be concentric for precision crowning. The lathe crowning tool, shown at top, does an excellent job.

Finish Ream Chamber, Continued

Use even pressure on the T handle and reamer. Keep the T handle shank as centered as possible and flow cutting oil into the chamber to flush out small particles while reaming.

3. Remove the reamer, clean the chamber, and recheck headspace frequently with the previously mated bolt and a go gauge until the bolt will just close with light drag on the go gauge head. Make 100% sure that the gauge does not false headspace on a particle or chip in the chamber.
4. When the bolt will just close on a go gauge, lightly hone and polish the chamber walls with extra fine Scotchbrite on a dowel. Do not permit the dowel or the abrasive to enter the chamber throat and bore.
5. Then detail clean the chamber and closely inspect the interior with a bore scope or small bright light.

If any irregularity is detected, cast the chamber and throat area with Cerrosafe and inspect and measure the casting. If the chamber is acceptable, complete the following work.

Note: If the chamber is scored or cosmetically imperfect, requalify the barrel and recut the chamber. Barrels must be replaced if reamer chatter marks are present or if the chamber is off center, oval, or otherwise mechanically imperfect.

Complete Barrel Lathe Work

1. After the chamber is finish reamed or semi-finished on the lathe, make the cartridge case exposure check discussed in figure 230.
2. Then cut the chamber mouth 45° chamfer. On M98 barrels, clearance the last half thread and the secondary torque shoulder. See fig. 234.
3. Final polish the rear barrel face and the chamber mouth opening chamfer with fine Scotchbrite.
4. Set up barrel and cut the muzzle crown. See figure 231.

Note: When barrel final torque position is known, see page 188, the barrel can be chamber stamped and polished on the lathe, at this time, with fine sandcloth or Scotchbrite and solvent. See barrel exterior honing and polishing lathe attachment and setup in figure 267.

When measuring receivers for barrel replacement, make a detail sketch as shown in figure 233, and fill in the correct barrel fitting dimensions.

Barrel runout can be reduced to well below 1/10,000" when steady rest setups are used.

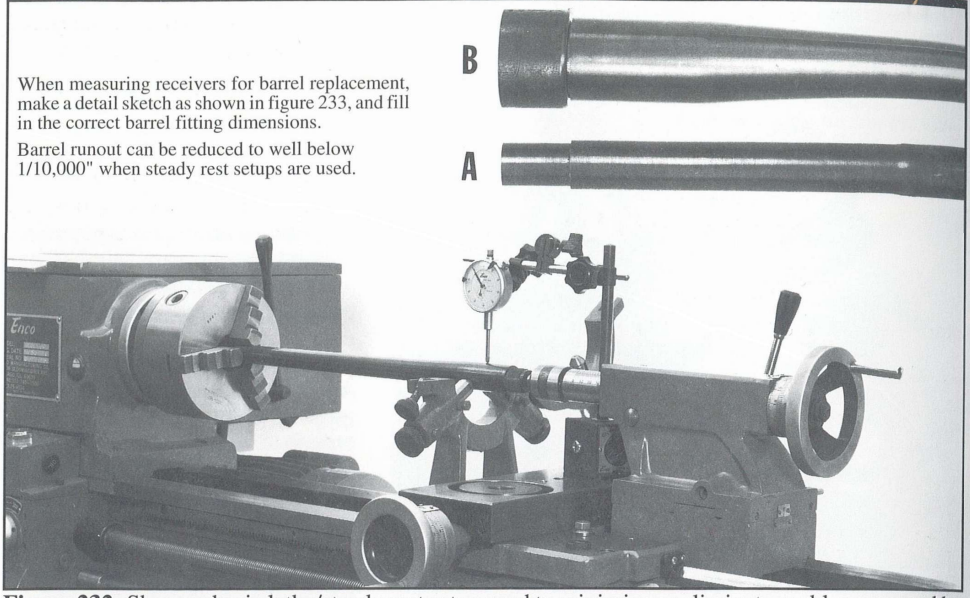


Figure 232- Shows a basic lathe/steady rest setup used to minimize or eliminate problems caused by lathe headstock/chuck runout and headstock vibration. Before setting up an unthreaded barrel blank in the lathe, tailstock alignment must be checked with lathe centering buttons and a dial indicator or micrometer, as discussed in figure 223. Barrel runout is checked with a large-dial dial indicator (1 revolution = .100"). The stepped, muzzle end driving shank shown above at **A**, and discussed below, is cut off before the barrel is crowned. Already threaded barrels can be driven from a faceplate, center, and lathe dog setup, or by installing a threaded driver, as shown at **B**, and installing the driver directly in the three jaw chuck. Barrel blanks are threaded and chambered as follows:

1. Drive the thread end of the barrel as discussed above and center drill the muzzle end of the blank, or install a brass centering insert in the bore.

2. Install the live center and runout check and true the first 2" of the muzzle end of the barrel, following the original taper of the contoured blank. Then, machine the last 3/4" straight (without taper) to form a lathe chuck driving shank. See **A**, above. The driving shank is cut off when the muzzle is crowned.

3. Then, install the muzzle end driving shank in the 3 jaw chuck. Center drill the chamber end of the blank or install a brass centering insert in the bore.

4. Install the live center and runout check and pretrue the cylindrical shank portion of the barrel.

5. Now, install the steady rest, adjust to the cylindrical barrel shank, and remove the live center. Install a steel centering pin in the bore and indicate. Adjust the steady rest until runout on the centering pin is at minimum (usually less than a quarter graduation needle tick) and remove the centering pin.

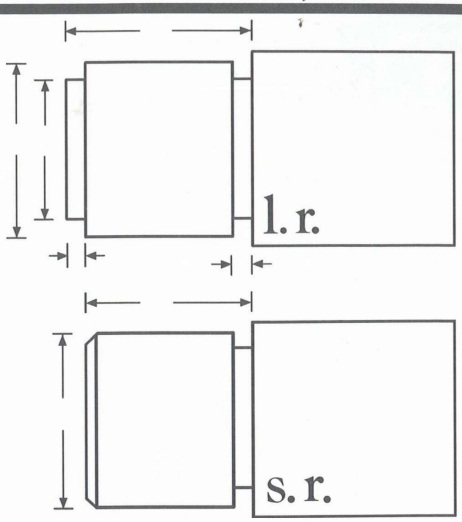
6. With the barrel in the steady rest setup, turn the thread extension shank to an outside diameter that is equal to the major thread diameter needed to fit the receiver (threads are adjusted later for clearance). Make the thread extension shank slightly longer than needed to allow for final trimming.

7. Lathe cut 55° or 60° barrel threads to match barrel threads in the receiver.

8. Trim the barrel shoulder/rear barrel face to exact thread extension length needed to fit the receiver. Check fit by screwing on the receiver by hand with the barrel still in the lathe. Adjust thread diameter and thread extension length as necessary to exactly fit the receiver. See M98 final fit note in fig. 234.

9. Rough ream and finish ream the chamber with the barrel in the same steady rest setup. Gauge check and final adjust headspace on the lathe or gauge check and finish ream chamber after barrel is installed.

Regardless of the lathe setup used, the importance of minimizing runout in barrel work can't be over stated. Original setup errors can't be overcome later and are, in fact, always compounded. No matter how careful the lathe operator is- if the barrel is not concentric at the thread end before machining the thread extension shank, cutting the threads, and reaming the chamber, the chamber will be off center and/or cut oversize.



When measuring a receiver for barrel replacement, make a similar sketch and fill in the correct barrel fitting dimensions.

Figure 233- Shows simplified barrel thread extension detail drawings used in fitting large and small ring Mauser sporter barrels. Actual thread diameter and barrel thread extension length is determined only by measuring an individual receiver after the torque shoulder surfaces have been trued and the threads cleaned. See figures 218 through 221.

Important M98 final barrel fitting note: Before installing M98 barrels, clearance trim secondary torque shoulders .001"-.0015" so that the main torque load will be placed on the receiver primary torque shoulder when the barrel is tightened. This minimizes receiver ring and thread stress.

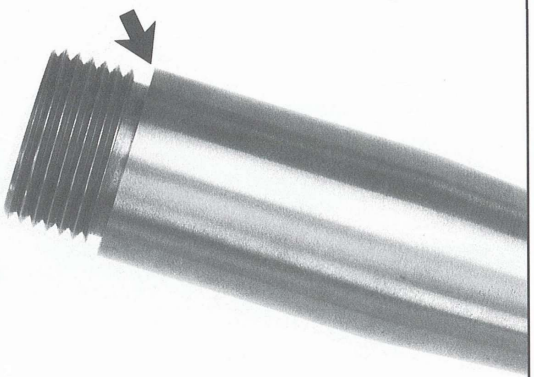


Figure 234- Shows a large ring M98 contoured barrel blank after barrel threads have been lathe cut. The threads have been sized and adjusted to fit the receiver and to thread in by hand with a light drag fit. Buffing the threads lightly on a soft wire wheel can help if threads are still slightly tight. 60° threads can be cleaned and adjusted as shown in figure 219.

More About Cutting Barrel Blank Threads and Chambers-

Reasonably concentric cylindrical barrel shanks can be directly installed in a lathe 3 jaw chuck to trim and adjust barrel torque shoulders and rear barrel faces, as shown in figure 224. ***End cuts*** of this type are not particularly affected by the lathe headstock/chuck runout present in the average shop lathe or by slight barrel nonconcentricity.

Installing barrels directly in a three jaw lathe chuck to make ***cylindrical cuts***, however, is a completely different matter.

In this case, lathe headstock/chuck runout, slight tailstock misalignment, and even slight barrel nonconcentricity that, by itself, might be considered tolerable by some, would multiply, and at least double, to create serious barrel machining errors. Barrel thread extension shanks and barrel threads that were being machined under these conditions would wind up being undersized and/or off center or otherwise miscut. Chambers reamed under these conditions would be oversized and, in some cases, off center or ovalled in the neck area unless a floating reamer holder was used. Runout causes chamber centering errors which usually become progressively worse as a chamber is cut deeper.

With the above in mind, do not chuck barrels directly in shop lathes to machine barrel thread extension shanks, cut barrel threads or adjust barrel thread diameter, or rough or semi-finish ream chambers.

However, when a steady rest setup is used, lathe headstock and chuck runout can be easily adjusted out over the length of a rifle barrel. In this case, the lathe chuck is used to approximately center and to drive the barrel. By using a steady rest, an average shop lathe can be used wih incredible accuracy.

Index Mark Barrel/Receiver for Final Rotation

Barrel installation index marks can be placed on the barrel and receiver when barrel fitting and chamber work have been completed.

Either of two following methods can be used to set final barrel rotation:

A. The tighten barrel to a predetermined torque setting method is particularly useful when torque shoulder surfaces are true and smooth. With this system, barrels are tightened only the minimum amount necessary. An advantage is that barrel/receiver thread stress is minimized. See barrel torque data in figure 235.

B. The rotate barrel to a predetermined position method is more commonly used and necessary when barrels have been drilled and tapped or dovetailed for open sights. Barrels that are to be requalified often fall into this category. There is no set amount that a barrel must be rotated from hand tight to be considered tight enough. Final rotation can be as little as .100" with well fit barrels and receivers to as high as .130" with others. Torque surface finish and barrel/receiver thread condition determine. Average final rotation distance is .125".

Final barrel rotation must be taken into consideration when drilled and tapped barrels are to be "clocked" to place the screw holes at TDC. Barrel torque shoulders must be adjusted accordingly. In this case, a standard final rotation allowance is used, such as .125". See figure 236.

Chamber Mark Barrel

Barrels can be chamber stamped before or after installation. However, it is easier to level flaring around newly stamped characters and detail polish barrels and receivers separately before final assembly. Barrels and receivers that are to be rust blued are assembled after bluing.

Tape lines or light scribe lines are placed on the barrel to align stamps and to keep impressions parallel. Solid one piece gunsmith's stamps, as shown in figure 236, are available from Brownells, Inc. Solid stamps produce a more professional appearing imprint.

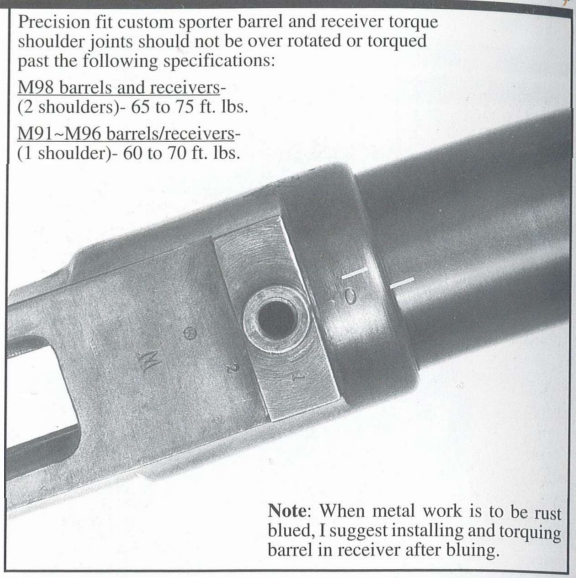


Figure 235- Shows a barrel hand tightened in an M98 receiver after the torque shoulders have been fit. If the barrel is to be torqued to 12:00 o'clock (torque shoulders must be preadjusted accordingly) index mark the bottom of the receiver. Mark the barrel about .125" behind the receiver index mark. Well fit barrel/receiver torque joints need not be rotated more than about .100" to .130" max. past hand tight.

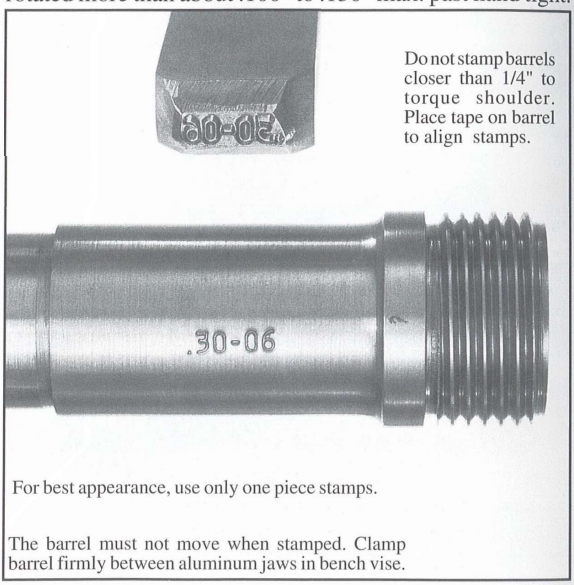


Figure 236- Shows cartridge chambering mark stamped on the left side of the barrel above the stockline. Chamber stamp position can be determined when the barrel is screwed in and hand tight, as shown in figure 235. Position the chamber mark high enough so that the riflesmith's name imprint can be stamped below.

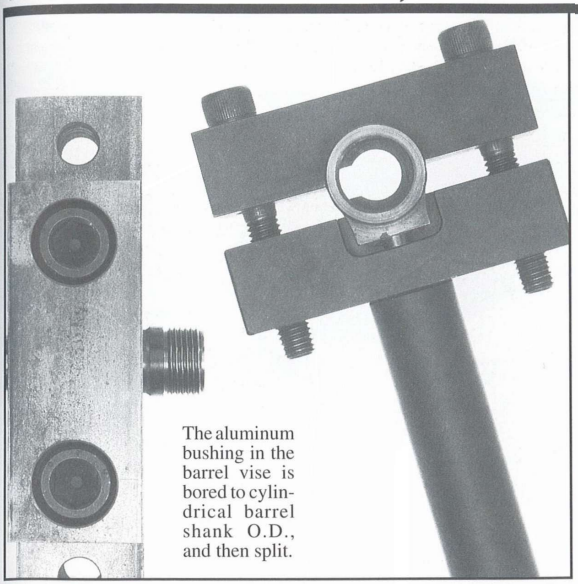


Figure 237- Shows barrel set up in barrel vise, at left. The aluminum barrel bushing and barrel are coated with powdered rosin. If a barrel index mark is used, it should be visible at the approx. 3:00 o'clock position. The receiver is shown secured in the action wrench, at right. Brass shim stock or paper between wrench head and receiver ring can compensate for radius differences and protect finished receivers.

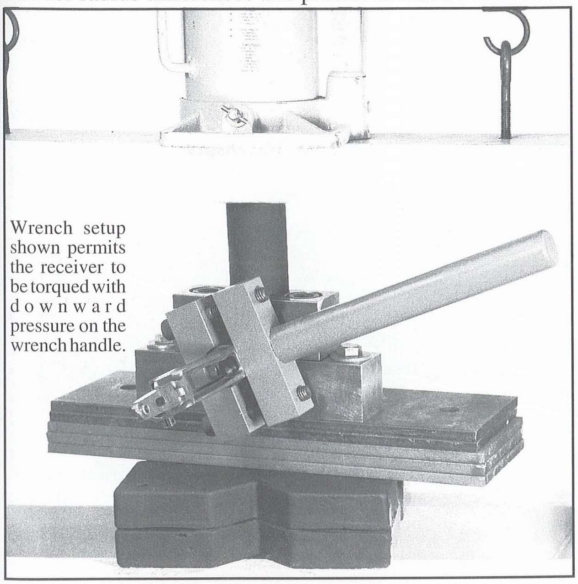


Figure 238- Shows an M98 receiver (with action wrench) threaded onto barrel secured in barrel vise in shop press. The receiver can now be final rotated to align the barrel/receiver index marks, or tightened to the torque settings discussed in figure 235. Press hydraulic pressure is increased and vise bolts retightened before the wrench and receiver are turned. The barrel must not slip once secured in the barrel vise.

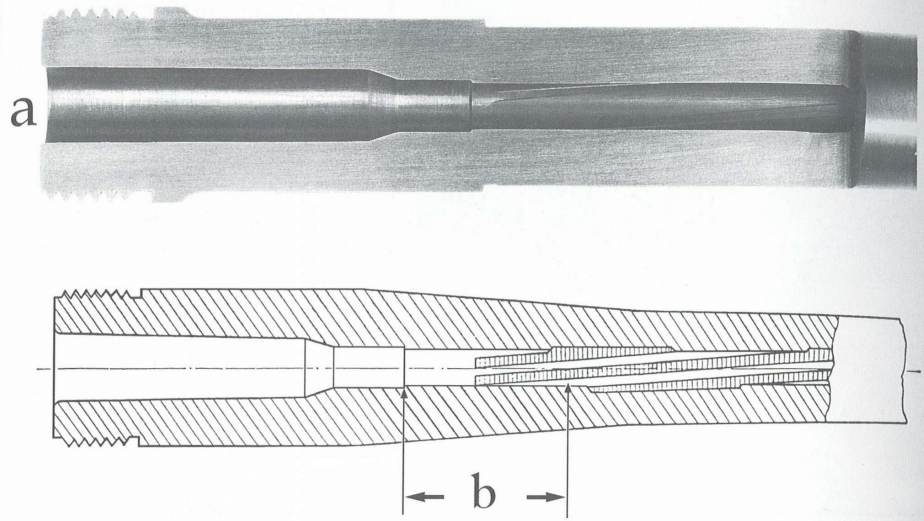
Torque Barrel and Receiver

Barrels are installed after receiver reheat treat and/or rust bluing.

Note: When installing sporter barrels, I suggest using barrel vises that will accommodate either aluminum barrel bushings or hardwood barrel blocks. Steel bushings can be used to install military barrels and to remove overtorqued barrels, but can mar finishes and/or dimple softer barrels if not used with extreme care. Aluminum bushings are recommended for barrel installation.

1. Set up the barrel in an aluminum barrel bushing in the barrel vise. Coat the cylindrical barrel shank and both sides of the bushing with powdered rosin. If index marks are used, rotate the barrel to place the index mark at the approx. 3:00 o'clock position before tightening the barrel vise. See figure 237.
2. Apply press hydraulic pressure and tighten the barrel vise bolts.
3. Install the action wrench with the correct size wrench head on the receiver. Place paper or brass shim stock between the wrench head and receiver ring to protect and support the ring. Tighten the wrench until it just feels solid on the receiver. Do not over tighten the wrench.
4. Lube threads and torque shoulder surfaces with antiseize compound or graphite grease. Then, thread the receiver onto the barrel until it stops. See figure 238.
5. Apply press hydraulic pressure and recheck and tighten the barrel vise before torquing the receiver. The barrel must not slip in the vise.
6. If the barrel torque method is used, tighten M98 receiver/barrel torque joints to about 65-75 ft. lbs. Tighten M91~M96 receiver/barrel torque joints to about 60-70 ft. lbs.
7. If the barrel/receiver index mark method is used, final rotate receiver until index marks agree.

Note: Torque shoulders on requalified barrels with sight dovetails or screw holes must be carefully preadjusted and indexed so that sights will be exactly at TDC when the barrel is tightened.



Drawing exaggerated for example.

Figure 239- Shows an M98 barrel chamber, at **A**, that was reamed with a standard integral throat type finish reamer. The tapered bullet seat transition and chamber throat begins just at the end of the chamber neck. In the long throated (or free bored) chamber, illustrated below at **B**, the bullet seat taper and throat are further forward in the bore.

Most standard commercial throating reamers cut a 2 1/2° throat taper and are sized approx. .002" over bullet diameter. In most barrels, this diameter will ream the free bore area close to the same diameter as the bottom of the rifling grooves.

With very few exceptions, hunting rifles that are chambered for standard commercial cartridges should be finish reamed with integral throat type finish reamers. When hand loaded ammunition is to be used in standard chambers, bullets should be seated to about .001"-.002" short of contact with the beginning of the rifling lands in the chamber throat. This can't be done when bullets are too short.

Special purpose hunting, varmint, and target rifles, and rifles chambered for wildcat cartridges should be chambered with no-throat type finish reamers. Chamber throats are then reamed to accommodate the seated bullet position of the round to be fired (plus desired free bore, if any). Sample dummy rounds with bullets seated to exact depth should be used to set up and check throat depth.

When excessive free bore is present, the chamber throat is too long. This condition permits bullets to accelerate before the rifling is engaged. The abrupt contact and twisting force that results deforms bullets and creates inaccuracy.

Chamber throats that are undersize or too short do not allow bullet clearance. This condition affects pressure curves, sometimes seriously, and can also upset bullets. Seating bullets .001"-.002" short of rifling contact, or providing the equivalent amount of freebore if bullets are long, can be helpful with higher pressure cartridges.

As far as barrel performance is concerned, the net effect would be the same whether bullets were seated to fractionally clear the lands in a standard chamber throat or the throat was reamed to fractionally clear the bullet at a desired seating depth. In either case, the bullet would have the necessary clearance to begin forward movement and gradually engage the lands in the chamber throat and to begin rotation while accelerating. In this way, bullet deformation is kept to a minimum which, in turn, helps optimize performance on target.

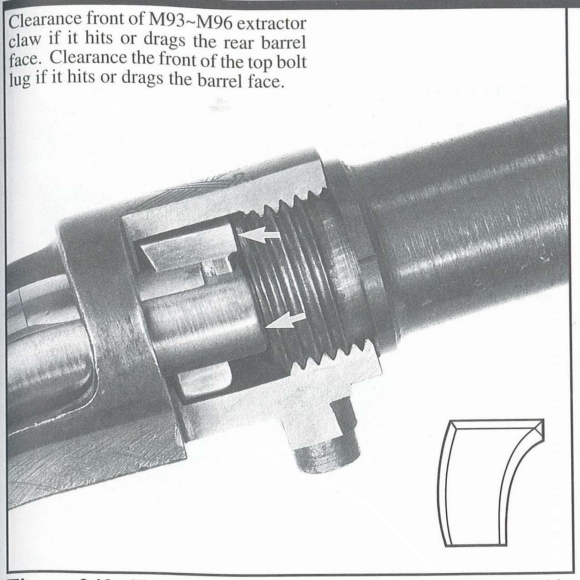


Figure 240- Shows a requalified military barrel installed in a sectioned M95 receiver. After barrel installation, the bolt is checked for receiver drag. Improper tooling and/or an overtight wrench can oval the receiver ring. Top front bolt lug clearance and extractor claw clearance are checked at arrows, above. Coat the front of the extractor claw and top bolt lug with Dykem Blue for this check.

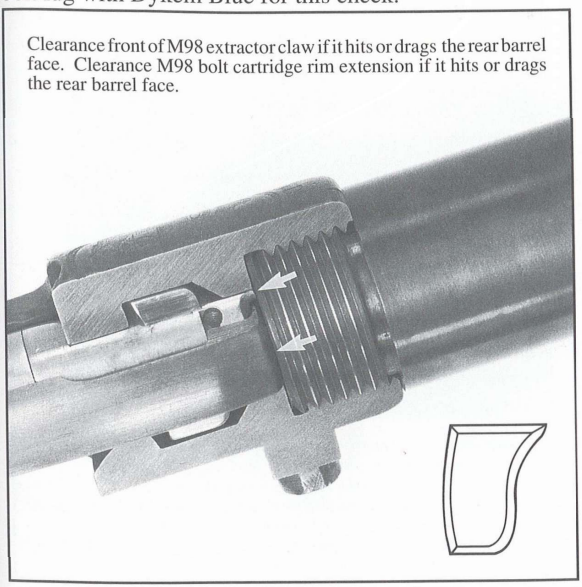


Figure 241- Shows a sporter barrel installed in a sectioned large ring M98 receiver. Although action wrench ovalled large ring receivers are less common, check points are basically the same as for the small ring receiver, above. The front of the extractor claw and the bolt's cartridge rim extension are clearanced if they hit or drag the rear barrel face. If in doubt, try the bolt without the extractor.

Bolt and Extractor Clearance

Final barrel/receiver torques greater than discussed in figure 235 and on page 189 are not required with well fit barrels.

A well made action wrench with correctly contoured small and large ring diameter Mauser heads will not wrench oval or squash Mauser receiver rings when the wrench is properly set up (and is not over tightened) and when the receiver and barrel are not torqued beyond the limits suggested in figure 235.

After the barrel is installed, check bolt/receiver, bolt/rear barrel face, and extractor/ rear barrel face clearance as follows:

1. Coat the front 1/3 of the bolt body and the end of the extractor with Dykem Blue.
2. Install the bolt and push forward. Feel for drag or resistance on the bolt body or the top of the extractor as the body enters the receiver ring.
3. If bolt body clearance is O.K., close the bolt slowly and feel for bolt or extractor drag as the bolt lugs cam into locked position.

Note: The front of an M91~M96 top bolt lug should clear the rear barrel face by approx. .003". The front of an M98 bolt cartridge rim extension should clear the barrel face by .002", or more.

4. If the front of an M91~M96 bolt lug or an M98 cartridge rim extension drags and requires clearancing, carefully clearance and dress with a fine Arkansas stone.

Caution: Stone surfaces just enough to provide clearance. Do not undersize.

5. If the front of the extractor claw hits the rear barrel face as the bolt is closed, clearance the front of the claw just enough to eliminate rear barrel face contact.

Caution: Clearance the front of the extractor claw only. If thinned too much, the claw will break.

About M98 Magazine Well Length and Cartridge Length-
Most standard length military M98 actions have magazine wells that measure 3.315" long on the inside to accommodate 7x57mm or 8x57mm military service cartridges. This dimension is too short for the overall length of many .30-06 cartridge loadings. It is also too short for most short magnum cartridge loadings.
As far as magazine well length (only) is concerned, any of the following basic remedies can be used when a standard M98 action is rebarrelled and chambered for .30-06 length cartridges:
1. Use only shorter, lighter bullet weight cartridges in 57mm case length magazine wells.
2. Adjust well length in 3.315" magazines by cutting and modifying the front of the magazine well to increase inside length to 3.400" to handle .30-06 length cartridges with longer bullets. See figs. 242 and 243.
3. Replace the trigger guard/magazine housing with an accessory housing that has a 3.400" .30-06 length magazine well.

About M98 Magazine Well Taper-
It is an old and established rule that magazine well sidewall taper must agree with the rim-to-shoulder taper of cartridge pairs inside the magazine. When magazine well taper is correct, actual width of the magazine is not important. A narrow, correctly tapered magazine will displace cartridges vertically and evenly.
However, when sidewall taper is not correct, cartridge rims and/or shoulders will drag or bind inside the magazine well. Past a point, cartridges will not stack in the magazine and support each other evenly,as shown in illustrations in fig. 244. In extreme cases, the fronts of the cartridges in the magazine will displace left/right or float. This condition causes cartridges to stand up or pop out when the bolt is cycled in an attempt to feed a cartridge from the magazine. When actions are converted to fire longer rimless cartridges, or rimless cartridges that are larger in diameter-

In standard length M98 actions, 7x57mm and 8x57mm magazine well openings measure 3.315" long. .30-06 length magazine well openings measure 3.400" long. The difference is .085", or the approximate thickness of the front magazine box wall.

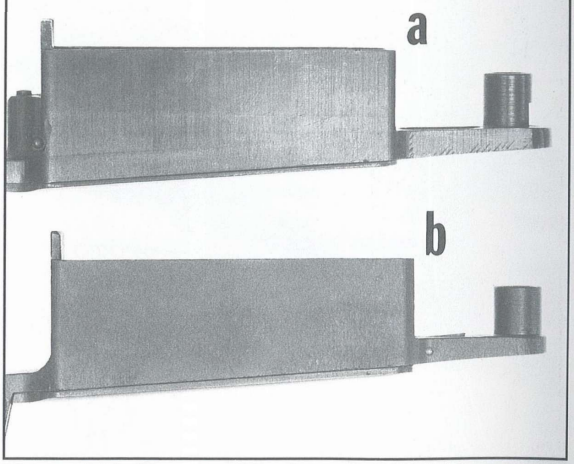
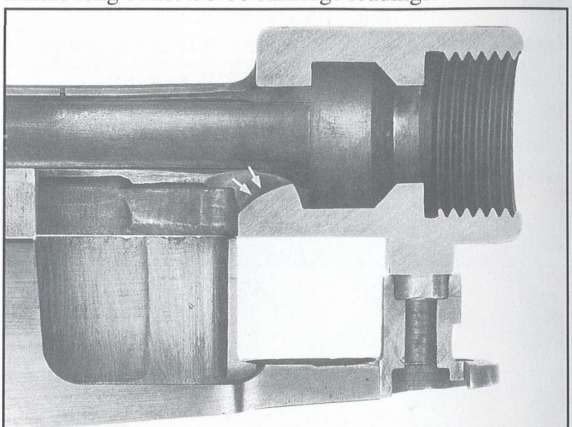
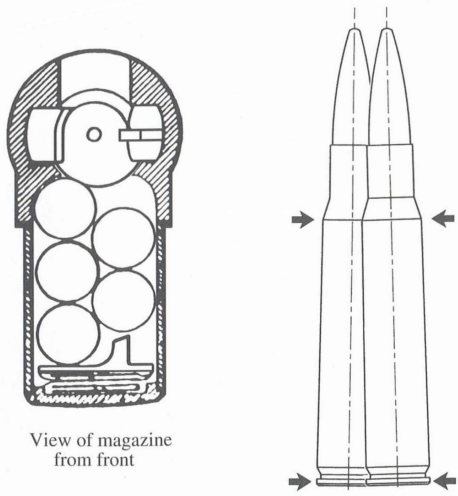


Figure 242- Shows a side view of a .30-06 length M98 magazine well, at **A**, and a standard M98 7x57mm/8x57mm magazine well, at **B**. Shorter bullet .30-06 cartridges will feed from a 57mm case length magazine well when magazine sidewall taper and receiver magazine rail feeding taper are adjusted. The magazine well length must be modified to handle long bullet .30-06 cartridge loadings.



Standard 57mm case length magazine wells can be length modified to feed longer bullet .30-06 cartridges in two ways:
1. Cut the front corners of the magazine box about 2/3 of the way down from the top. Bend the front wall so that the top corner is moved .085" forward. Then weld magazine corners and file to shape.
2. Cut out entire front of magazine box and reposition .085" forward. Then, weld front of magazine well back in and file to shape.

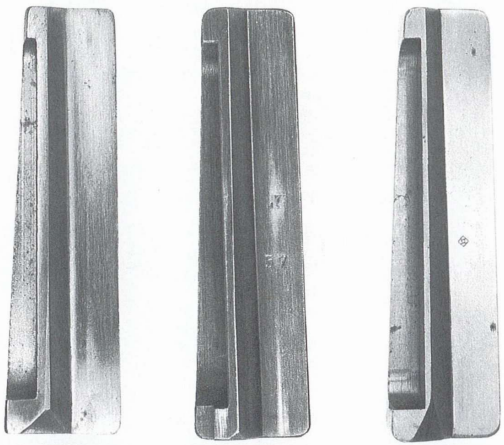
Figure 243- Shows a half sectioned standard length M98 military receiver with magazine opening adjusted .085" forward to feed longer bullet .30-06 cartridges. A cutaway standard length 8x57mm magazine well (3.315" long) is shown installed on the receiver for comparison. M98 receiver ramps typically require adjustment at arrows, above, to feed longer or larger diameter cartridges.



View of magazine from front

Illustrations not to scale

Figure 244- Illustration, at left, shows a staggered two row Mauser magazine. The guide rib on the follower was designed to act as the first cartridge in the magazine. Magazine well sidewall taper must match the rim-to-shoulder taper of cartridge pairs in the magazine. If taper doesn't agree, case heads and shoulders will bind, or drag. In worst cases, fronts of cartridges will float and stand up as the bolt is cycled.



Final magazine follower guide rail adjustment and polishing is done after the cartridge feeding taper at the front of the receiver rails has been adjusted to feed cartridges with shoulder sections that are further forward and/or larger in diameter.

Figure 245- Shows three slightly different military production M98 magazine followers. Cartridge guide rib angle and thickness is different on each. Trial install a follower with a thinner guide rib before adjusting the cartridge feeding taper at the front of the receiver's magazine rails. The receiver's parallel magazine rails are always adjusted last.

About M98 Magazine Well Taper, Continued-

through the shoulder section, magazine well taper can be adjusted by spreading the magazine at a forward point that corresponds to the position of the shoulders of the cartridge pairs as they would ride in the magazine. Magazine well taper is adjusted until it agrees with the rim-to-shoulder angle produced when cartridges are stacked, as shown in figure 244.

Larger rim diameter cartridges, such as the belted magnums, may require clearancing the back of the magazine well before adjusting sidewall taper.

Conversion fitting sequence:

1. Adjust magazine well taper to agree with stacked cartridge pairs.
2. Select a follower with a thin guide rib to minimize cartridge shoulder bind as cartridges are pushed forward into the feeding taper at the front of the receiver's magazine opening.
3. Adjust the receiver magazine rail feeding taper to permit cartridge shoulders to clear and ramp.
4. Fine adjust and polish the magazine follower.
5. Adjust and polish the receiver parallel magazine rails, if needed.

About Magazine Followers-

If the guide rib on the magazine follower is too wide or positioned too far to the right, the shoulder of the number one cartridge in the magazine will drag on the right magazine rail feeding taper as the cartridge is pushed forward. A second cartridge in the magazine would drag on the left magazine rail feeding taper.

When an attempt is made to feed longer cartridges or cartridges that are larger in diameter through the shoulder section through a receiver magazine opening with feeding taper sized for 57mm cartridge cases, this condition can become severe enough to bind or jam the cartridge shoulders as they are pushed forward.

In either case, install a magazine follower with a thinner (more to the left) cartridge guide rib before attempting to adjust the receiver magazine rail feeding taper surfaces at the front of the magazine opening.

Check and Adjust Receiver Magazine Rails

When M98 actions have been rebarrelled and chambered for longer or larger diameter cartridges, the magazine rails will almost always require adjustment to compensate for the difference in cartridge shape and shoulder location.

Because it is a lot harder to put metal back than take it off, this work must be carefully done on a right/left rail, trial feed basis, until cartridges feed and breakover smoothly.

1. Make sure the magazine follower spring is of the correct size and strength.
2. If not done already, lightly chamfer and polish the inside bottom magazine rail corners to eliminate rough areas and burrs that would make cartridge feeding resistant.
3. Load the magazine with one dummy round. See figs. 246 and 247.
4. Check feeding: if the cartridge cants too much to the left as it ramps, hits the chamber mouth, or jams in the magazine rail taper area, clearance the right magazine rail taper surface or move it forward to minimize cartridge shoulder drag and permit the cartridge to line up with the chamber.
5. Then load a second cartridge and check feeding on the left side. Adjust left magazine rail taper surface as discussed above. See figure 247.
6. If larger diameter cartridges bind on the parallel receiver magazine rails, drag excessively, or strip hard from the magazine, carefully clearance the rails, one side at a time.
7. Then, rechamfer and polish the bottom inside rail edges until feeding is smooth.

Note: Breakover point can be somewhat different with the left and right cartridges. The right rail may require extra polishing to make the last cartridge strip smoothly.

Warning: Use extra care to prevent overadjustment of parallel rails. If rails are undersized, the magazine will no longer retain cartridges.



Figure 246- Shows dummy .30-06 cartridge being fed from magazine in an M98 action. The receiver magazine feeding taper, parallel magazine rails, and extractor claw must permit cartridges to strip and breakover (straighten and engage the extractor claw) when the bolt is about 1/2 to 2/3 of the way forward. The receiver's magazine rail feeding taper is clearance adjusted for longer or larger dia. case shoulders.

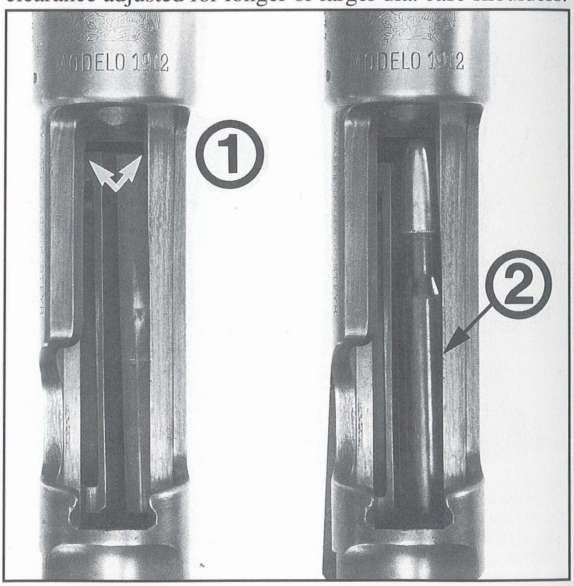


Figure 247- Shows receiver magazine rail adjustment areas. The receiver's magazine rail feeding taper is shown at **1**. Parallel magazine rails, at **2**, must be far enough apart to permit cartridge loading without the left side of the follower dragging on the magazine well and to permit cartridges to be stripped from the magazine without excessive rail drag.

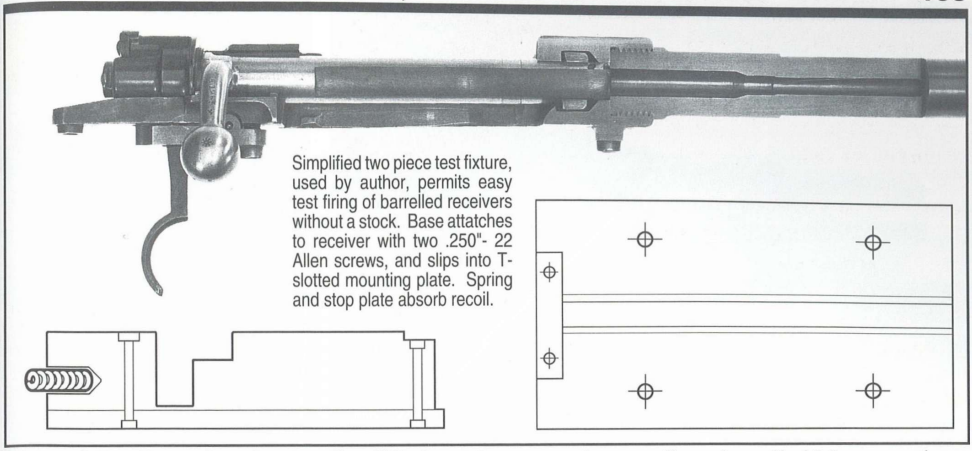


Figure 248- Illustration shows a simplified test fixture used to test fire rebarrelled Mauser actions. Military and commercial Mauser actions that have been in previous service, that appear to be in excellent condition, and that have passed all receiver, bolt, and parts serviceability checks/inspections up to this point, probably come as close to being "tried and true" as any rifle action could get.

Nonetheless, I would suggest final proof checking all rebarrelled actions to provide an extra safety margin both for you and your customer. The following standard pressure proofing method has been used by riflesmiths in the U.S. and Europe because it places maximum load on the bolt and receiver lugs without excessive pressure.

Warning: Because of the many variables in field test conditions that cannot be laboratory controlled, high pressure proof loads are not available to gunsmiths or to the public. Proof load data is not published in reloading manuals. Do not use high pressure proof loads in any firearm. Failure to follow this rule could result in serious injury or death.

Standard Pressure Proofing:

1. Detail clean and completely dry the chamber, bore, and action.

2. Install barrelled action in test firing fixture secured to test stand.

3. Select factory ammunition in the midweight bullet range. For example: if a .30-06 barrelled action is to be tested, test fire with approx. 150 grain bullets.

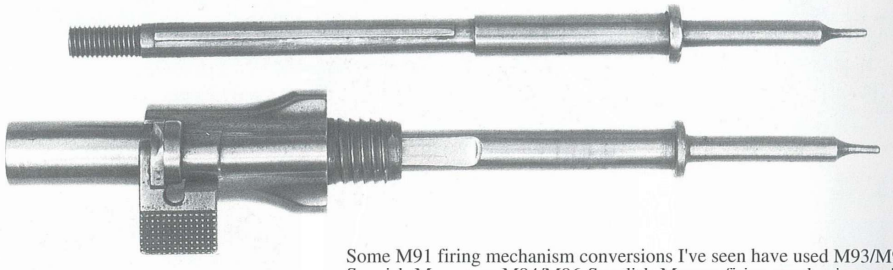
4. Roll cartridge cases on a case lube pad moistened with gun oil until the main case is lightly and evenly oil coated. Make sure that the case neck, shoulder, cartridge head, primer, and bullet are not oiled, and are 100% dry.

5. Put on suitable ear protection, place a round, oil coated as above, in the chamber, and lock the bolt. Stand clear, and fire the barrelled action with a lanyard.

6. Open the bolt and check case extraction. Lightly lubricated cartridge cases should not be hard to extract from a well reamed, polished, and correctly headspaced chamber. If case extraction is stiff, check headspace. If headspace is O.K., go on to step 7.

7. Now, test fire four more rounds under the same conditions and closely inspect brass cases for possible chamber or primer problems.

8. Detail clean the chamber, bore, and bolt face, after proof firing, and regauge headspace. If headspace is still O.K. and the receiver and bolt lugs appear as lapped and reheat treated earlier, the barrelled action can be considered serviceable. If headspace has increased .001" or more, the receiver lug area and/or bolt lugs may be soft. Remove barrel and inspect receiver for possible lug area seating or setback. Also inspect bolt lugs for seating. Reject the defective part(s) and mark not safe to fire.



Some M91 firing mechanism conversions I've seen have used M93/M95 Spanish Mauser or M94/M96 Swedish Mauser firing mechanisms with shortened firing pins. In many of the conversions, firing pin protrusion was too long or short. Buttress assembly threads in some Spanish made M93/M95 bolt sleeves are undersize and fit loosely in M91 bolts. This creates shallow or variable sear engagement. Replace loose bolt sleeves if found.

Figure 249- Shows an M91 Mauser firing mechanism replacement, at bottom, made from an M93/M95 type firing mechanism by shortening the firing pin. An M91 firing pin is shown above for comparison. The conversion shown was on a rifle purchased by a customer at a yard sale. The firing mechanism was functional but the firing pin was too long and pierced primers. Because M91 firing pins are becoming increasingly scarce, M91 conversions like the above are not uncommon. When you encounter one of these, check as follows:

Measure the distance from the front of the integral spring flange on the firing pin to the tip of the firing pin. Measurement should be approx. 1.485". The firing pin tip diameter should be approx. .076", and shank diameter behind the tip should be .215". Distance from the spring flange to the point where the firing pin begins to reduce in diameter should be 1.075".

To work properly in an M91 bolt, the front of an M93/M95 type firing pin must be shortened to the above dimensions. If making one of these conversions, it's a good idea to leave the firing pin tip slightly long and protrusion check the firing mechanism as discussed on page 56. Also see figure 57.

Check for sufficient cocking piece/sear engagement when inspecting one of these conversions. See inset copy above. Always check actions with these conversions to make sure firing mechanisms do not safety-off fire, slam fire, or impact fire. Also see figure 116.

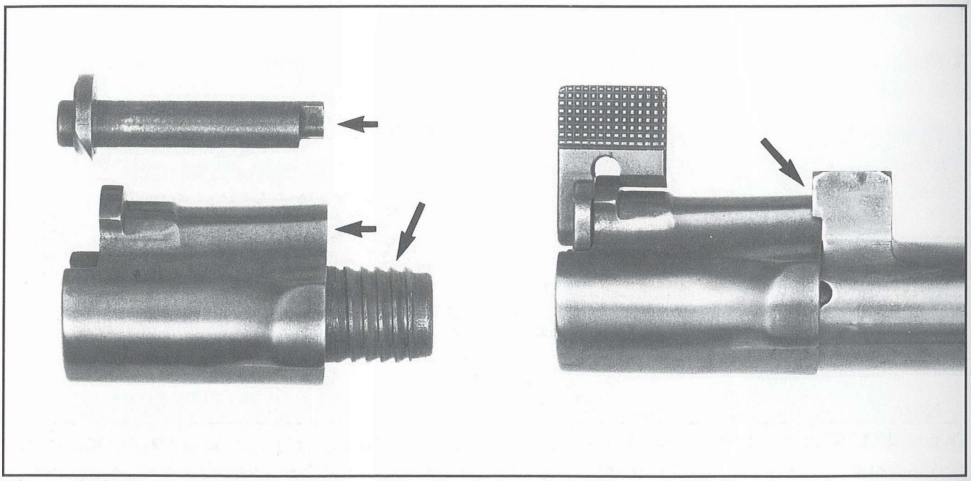


Figure 250- Shows an M93 bolt sleeve and safety lever at left. The assembled parts are shown installed on an M91 bolt body, at right. Arrows indicate fit check points. Bolt sleeves must be selected to fit M91 bolts without clearance wobble when threaded into the closed bolt position. If the end of the bolt sleeve drags the bolt, lightly clearance with a hard Arkansas stone. If bolt sleeve assembly thread fit is loose, the bolt sleeve can deflect as the bolt is closed and permit the cocking piece to bounce or slide over the sear and slam fire.

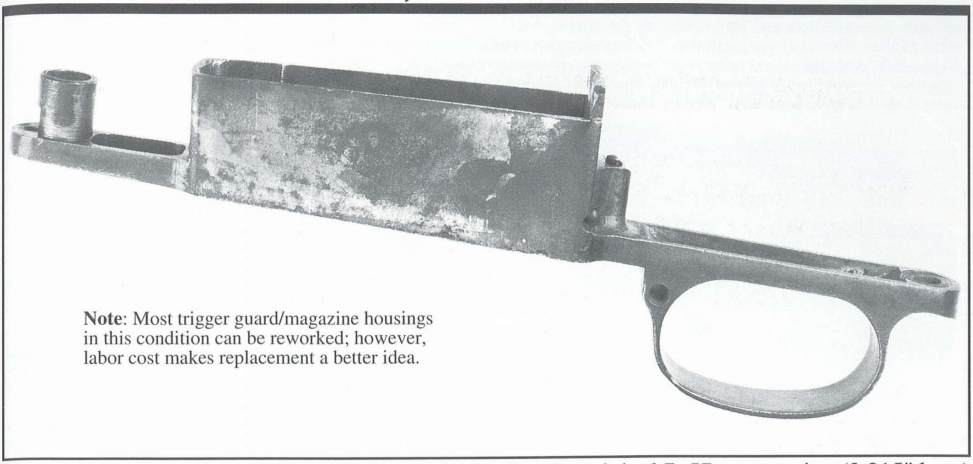


Figure 251- Shows a poorly modified magazine well. The original 7x57mm opening (3.315" long) has been blacksmithed forward at the top to agree with the .30-06 length magazine opening in an M98 receiver. Magazine housings lengthened in this way are found on some Colombian M98/35 Mauser rifles that were modified in the 1950's to fire .30-06 military cartridges. The trouble with some of these conversions, aside from the unprofessional appearance of the work, is that magazine housing assemblies were either stretched during the forming process or when they were jerked out of resistive stocks and bent. Stretching and rebending can spread the trigger guard/magazine housing receiver mounting screw hole centers and cause mounting screw bind.

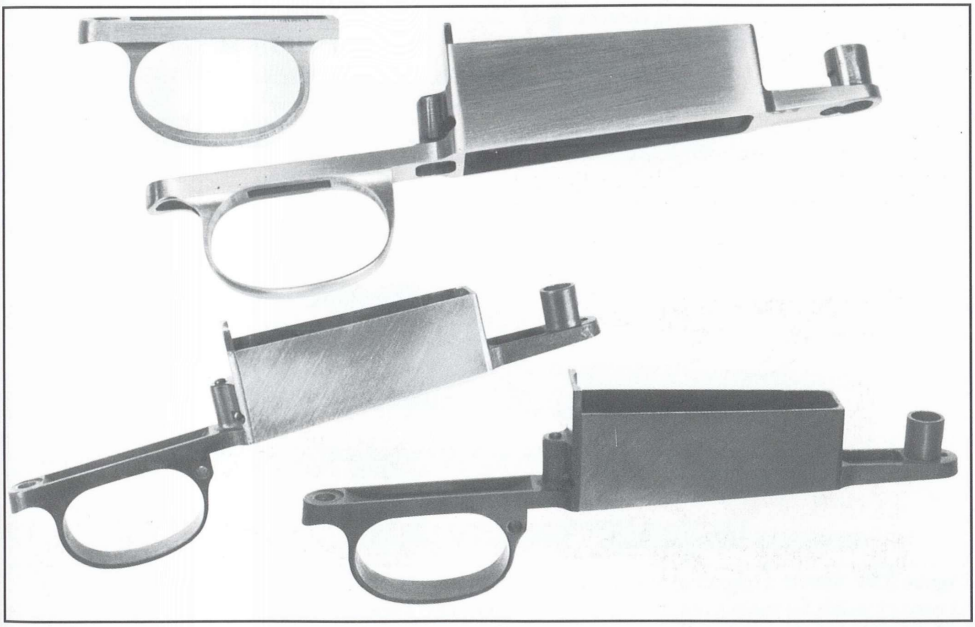


Figure 252- Shows a trigger guard that was cut off a damaged trigger guard magazine housing and recontoured. The trigger guard is ready to be silver brazed onto another magazine well. Stretched or otherwise damaged trigger guard magazine housings can be salvaged in this way, sometimes on a two for one basis. Silver brazed trigger guard joints can be made virtually invisible when the front of the guard is contoured to meet the magazine housing at 90° and the braze joint is in the corner. MIG welded trigger guard joints can be milled on a radius or hand filed and shaped as desired. Rust pits in the two trigger guard/magazine housings, at bottom, were MIG welded and resurfaced.

One of the easiest ways to section an M98 receiver is to clamp it securely on a milling fixture and remove a .625" section with a 5/8" end mill. In this way, a perfect section is removed and the two receiver halves will align perfectly when placed together for welding. Receiver halves should be aligned and clamped to a trued steel block before welding. Bolts and receivers that have been shortened and reassembled by welding must be annealed and reheat treated before use.

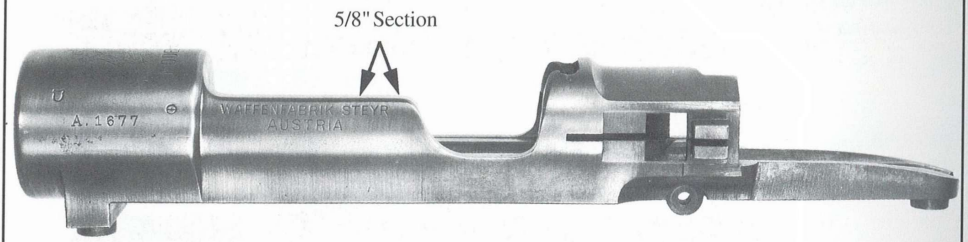


Figure 253- Shows a standard length M98 receiver (8 3/4" O.A.L.). Shorter "kurz" length (8 1/8" O.A.L.) M98 actions were used on Oberndorf Mauser commercial sporters chambered for smaller cartridges such as the .250 Savage. Although there are several workable ways to shorten standard length receivers to kurz length, I suggest cutting the receiver at 5" and again at 5 5/8" forward of centerline through the rear mounting screw, see arrows above. This provides maximum welding surface and also places the weld bead far enough away from the receiver ring and lug surfaces so that welding heat can be controlled.

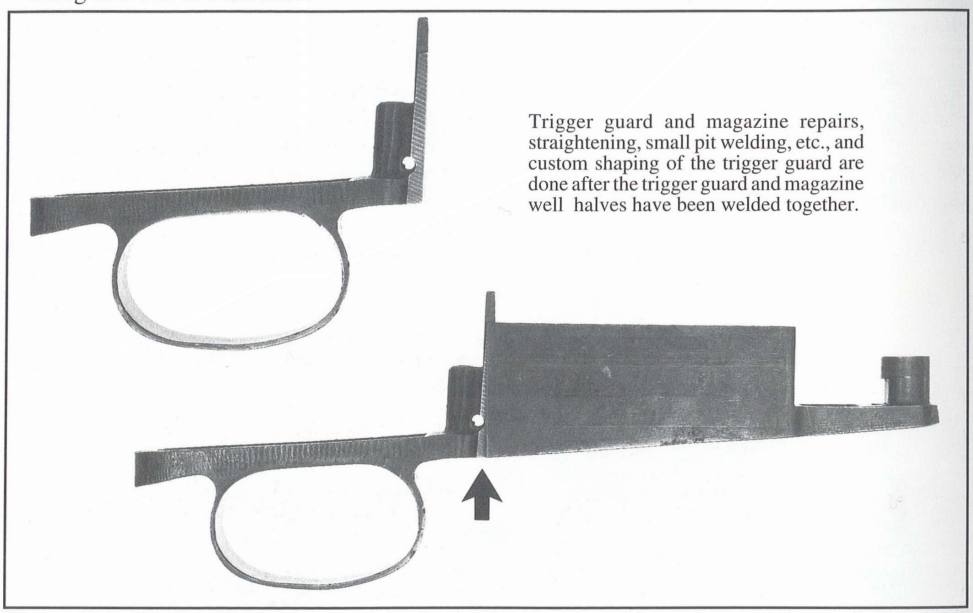
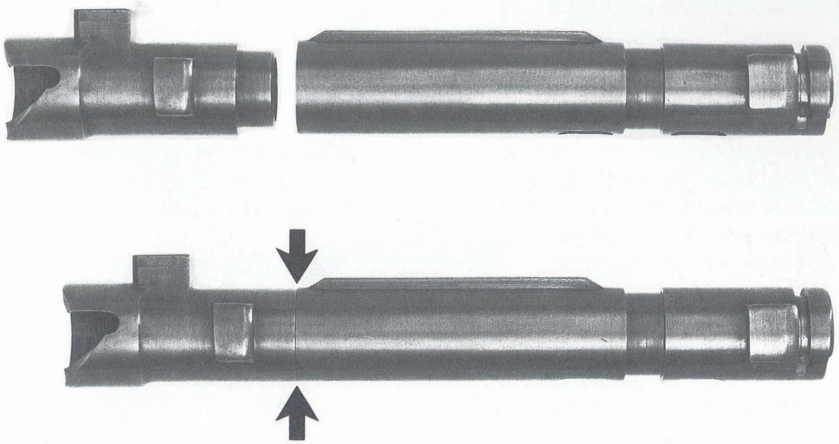


Figure 254- Shows a trigger guard, at top, that has been removed from the magazine well and milled to correct width for reassembly. A sectioned trigger guard and magazine well are shown in ready to weld position, below, after the magazine well has been shortened to the required length. The vee notched assembly joint at the back corner, see arrow, is weld filled and contoured to original shape. Trigger guard/magazine housings sectioned in this way are placed on the shortened receiver after it is welded and scribed where magazine well sidewalls are to be cut. Action shortening is discussed here and on page 199 to provide general information on the subject and help the gunsmith identify Mauser receivers that have been modified by sectioning. This work must be done only by a qualified precision gunsmith/metalsmith. Failure to cut, reassemble, or weld correctly can ruin a receiver or action parts and/or produce an unsafe action.

Caution: Bolt bodies that are not shortened the exact amount that the receiver is shortened can have rear bolt safety lug/receiver clearance problems. The original safety lug/receiver relationship must not be changed.



Warning: Bolt body and firing pin shortening is shown here to provide general information and to help the gunsmith identify actions and action parts that have been modified by shortening or sectioning. This work must be done only by precision metalsmiths who are fully qualified. Failure to cut, reassemble, weld, control heat, etc, correctly can ruin bolts and receivers and produce an unsafe action. Bolt bodies must be annealed and reheat treated after completion of work.

Figure 255- Shows an M98 military bolt body, at top, after a .625" x .575" O.D. sectioning recess has been cut and a .575" x .250 " tenon has been formed. The bolt body is shown slipped together, below, after the front half of the bolt body has been counterbored to receive the tenon. Bolt bodies are index marked on the bottom to maintain the alignment of the halves when the bolt body is reassembled. The exterior assembly joint is deburred to bring the halves together with a hairline fit, see arrows above, before 50% vee cutting the edges of the joint for welding. The bolt body is clamped lengthwise between copper blocks to bring the assembly joint into 100% contact before welding. M98 bolts are similarly lengthened, except that a longer front half must be taken from another bolt.

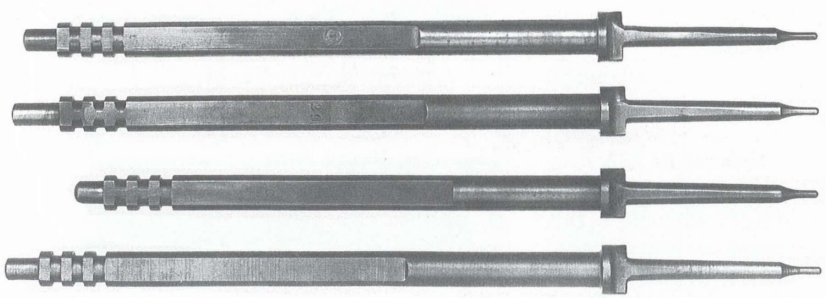
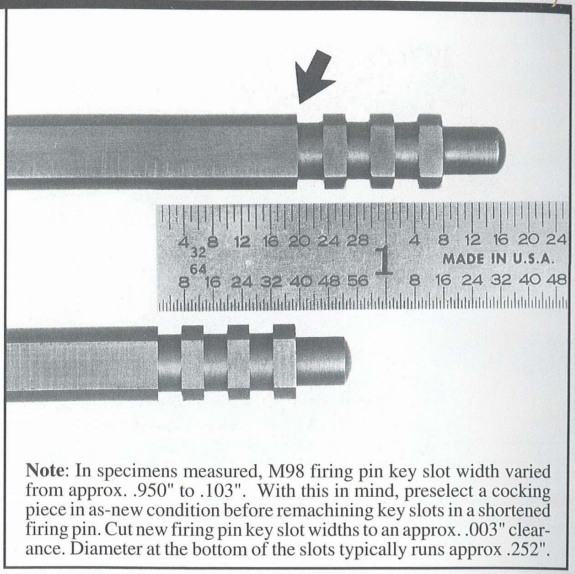


Figure 256- Shows four M98 firing pins for comparison. An intermediate action length Yugoslavian M24 firing pin is shown at top, and a Peruvian M1909 intermediate length firing pin is shown in second position. The basic difference between the two is that the M1909 firing pin has a longer rear shank for a long cocking piece. A kurz length firing pin is shown in third position. A standard length M98 firing pin is shown at bottom for comparison. See firing pin shortening on page 200. Firing mechanism assembly clearance cuts on the sides of shortened M98 firing pins must be machined forward.

Shorten M98 Firing Pin

The following firing pin shortening method does not require welding or brazing and is the best way to shorten a standard length M98 firing pin for use in an M98 bolt that has been sectioned to fit in a shortened "kurz" length M98 receiver and bolt, as discussed on pages 198 and 199:

1. Inspect the firing pin to be shortened to make sure the pin is serviceable and tip diameter is not undersize. Measure firing pin overall length and key slot position to be sure the firing pin can be modified.
2. Chuck the round part of the firing pin (just behind the integral firing pin retaining flange) in a 3 jaw lathe chuck and center drill a dimple in the round cocking piece alignment shank at the back of the firing pin. Drill just deep enough to accommodate the tip of a live center.
3. Layout and machine new firing pin key slots. Use a cocking piece in serviceable condition, as discussed in figure 257, or a firing pin in new condition as a pattern.
4. Machine a new round alignment shank on the back of the firing pin. Although typical diameter runs .212" to .215", I suggest machining the shank to the actual port diameter of the cocking piece to be used, minus .003" for clearance.
5. Then, cut the round alignment shank off at approx. .250" behind the firing pin rear key shoulder, shown at arrow in figure 257.
6. Mill the flats on the sides of the firing pin forward about 5/8". This permits the bolt sleeve to move ahead far enough for cocking piece installation clearance when the firing mechanism is assembled.
7. Check and adjust cocking piece fit on the firing pin. The cocking piece should fit the firing pin key slots with minimum play. However, fit must not be so tight that the cocking piece binds and is difficult to install or remove.



Note: In specimens measured, M98 firing pin key slot width varied from approx. .950" to .103". With this in mind, preselect a cocking piece in as-new condition before remachining key slots in a shortened firing pin. Cut new firing pin key slot widths to an approx. .003" clearance. Diameter at the bottom of the slots typically runs approx .252".

Figure 257- Shows a standard length M98 firing pin, at top, before shortening .625" to use in a shortened M98 bolt and action as discussed on pages 198 and 199. The rear firing pin key shoulder, at arrow, is left intact as a reference for machining new key slots forward, as shown on the firing pin below. Firing pin key slots inside M98 cocking pieces vary considerably but average approx. .102" to .110" wide.

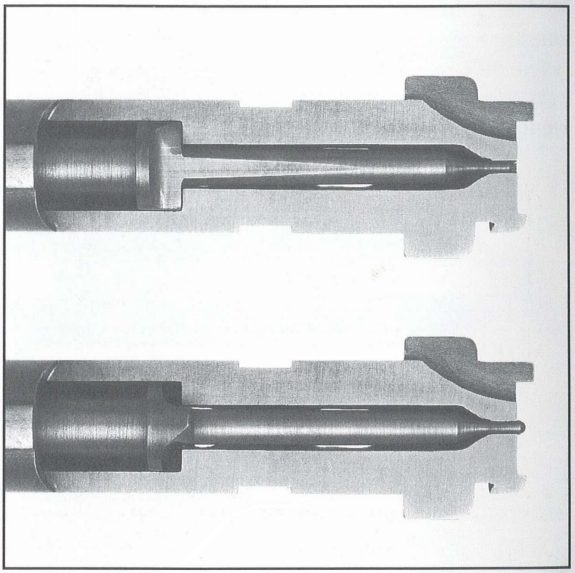
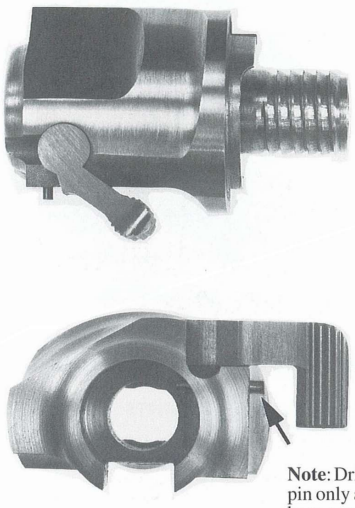
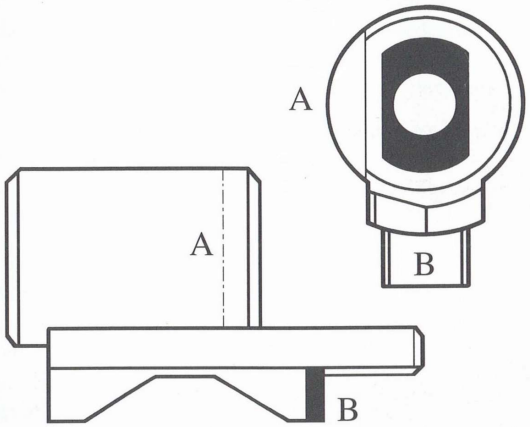


Figure 258- Shows M98 firing pin safety shoulders and tip being fit checked in a half sectioned M98 bolt body. The firing pin tip should not extend past .010" below flush with the bolt face when firing pin safety lug shoulders are against the stop surfaces inside the bolt body. Firing pin protrusion is checked with the bolt fully assembled. See pgs. 56 and 57.



Note: Drive in assembly pin only after fitting has been completed

Figure 259- Shows views of a streamlined bolt sleeve with Winchester M70 style three position safety lever, made for M98 actions by Precise Metalsmithing Enterprises. Custom safeties and triggers must be installed and function checked by a qualified gunsmith to eliminate the possibility of safety-off fires or other firing mechanism malfunctions. Always consult manufacturer's instructions before installation.



Caution: Cocking piece/ sear clearance must be checked and adjusted, if necessary, after cocking piece is adjusted for correct saftety lever function. Reheat treat cocking piece engagement ledge to C50 or C52 after adjustment. Mark X speed lock type cocking pieces require different fitting. Consult manufacturer's instructions, before fitting.

Figure 260- Illustrations show areas where a military M98 cocking piece is modified to function with the three position PME safety shown in figure 259. The 30° pickup surface, machined at **A**, permits the safety lever to cam the firing mechanism back. Cocking piece engagement ledge/sear clearance is checked and the cocking piece sear engagement ledge, at **B**, is adjusted to correct sear clearance.

M70 Style Safety Conversions

Side lever safety assemblies of this type provide scope clearance, add to the quality appearance of a well made custom rifle, and, if well fit, retain the positive safety function of the original Mauser military firing pin safety system. These conversions do require professional fitting. Always consult manufacturer's instructions.

Before driving in the tapered assembly crosspin, function check PME M98 Mauser safety assemblies (shown in figure 259) as follows:

1. With safety lever in center position, screw the bolt sleeve onto the bolt body until the safety plunger drops into detent slot (see PME fitting data).
2. If the safety plunger drags or catches, or will not permit the bolt to close, carefully adjust and chamfer the small bolt engagement end until function is correct.
3. Check for smooth safety lever movement to all three positions.
4. If travel is stiff or resistive, clearance and polish the safety detent slot at the back of the bolt.
5. Move safety lever to the safe position. The safety lever cam must push the cocking piece back smoothly.
6. If the cocking piece is resistant or will not move back, carefully clearance and polish the 30° bevelled surface shown in figure 260.
7. Then, check for correct cocking piece engagement ledge clearance.
8. If a commercial trigger is installed, carefully adjust the cocking piece engagement ledge surface until a minimum of .015" to .020" clearance exists between the cocking piece engagement ledge and the sear.

Military trigger sears require greater clearance. See page 52.

Warning 1: If the cocking piece engagement ledge is too far forward (does not have enough sear clearance), trigger movement or manipulation with safety on could permit the cocking piece to move forward, ahead of the sear. In this case, the safety engagement could release the firing mechanism as the safety lever was turned to the firing position.

Warning 2: The cocking piece engagement ledge surface must be kept perfectly square and at 90° to centerline. Reduced sear engagement can cause slam fires and/or impact fires. See pages 51 and 98.

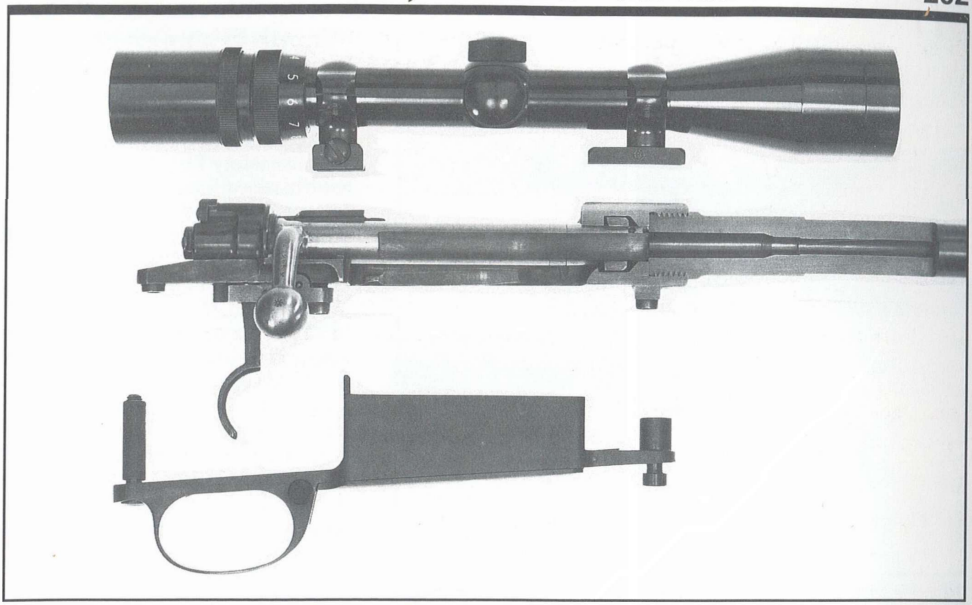


Figure 261- Shows a cutaway barrelled M98 Mauser receiver, at center. Nonfiring components are shown separated as a reminder that many factors are involved in making bolt action rifles group well on target. Common mechanical reasons that rifles do not shoot well or are *inaccurate* are listed below. Sight geometry, sight mechanical condition, and ammunition related problems that would cause inaccuracy are entirely different subjects and are not discussed here.

If a rifle will not shoot well from a rest with uniform ammunition, i.e., bullets string, do not group, and/or make oversize holes or keyhole on the target, mechanical problems exist in the rifle. Mechanical problems interact and compound to cause differences in the way individual cartridges fire and bullets travel through and exit the barrel. The net effect is erratic performance and dispersed groups on target.

On the other hand, uniform ammunition fired in a rifle with dimensions, tolerances, concentricity, and barrel/receiver stress within the acceptable range for the category of use, (and it's always a matter of degree) would tend to perform in a predictable way. When fired under controlled conditions, the combination of such ammunition and rifle would fire bullets very close to the same point of impact on the target. The net effect, in this case, would be predictable consistency on target.

What all this comes to is that an accurate rifle has the mechanical ability to fire successive, uniform cartridges in almost exactly the same way. Limiting bullet deformation to an absolute minimum is a necessary part of this. Keep in mind that, as concentricity problems and dimensional errors are reduced in any rifle, the circle within which bullets impact on target is also reduced. Any factor that would take away from this lessens mechanical repeatability of the firearm and increases bullet dispersal on target.

Basic Mechanical Reasons That Rifles Do Not Shoot Well

The reasons that rifles do not shoot well can be broken into any number of categories, all of which overlap to greater or lesser degree. For example: most chambers that are oversize were created when a nonconcentric bore was reamed or a chambering reamer was not set up in concentric agreement with the bore. In this way, a concentricity problem becomes a dimensional problem. For purposes of simplifying discussion and identifying problems, however, basic causes are grouped as follows:

Nonconcentricity and Concentric Misalignment

1. The bore and/or chamber are not concentric
2. The chamber is reamed on an angle

Basic Mechanical Reasons That Rifles Do Not Shoot Well, Continued-

3. The chamber is oval
4. The chamber throat is crooked
5. The barrel threads are not concentric
6. The receiver threads are nonconcentric
7. The bolt body is off center in the receiver (the bolt body is under diameter)
8. The bolt body is off center in the receiver (the receiver's round bolt guideways are undersized)
9. The bolt firing pin port is not in concentric agreement with chamber
10. The bolt cartridge centering radius is off center and permits bolt misalignment
11. The barrel crown is nonconcentric

Incorrect Dimensions and Plus/Minus Tolerance Accumulation

12. The chamber is oversize/undersize
13. The chamber is misreamed or otherwise deformed
14. The chamber throat/free bore is too long or too short
15. The chamber throat is eroded
16. The bore lands and/or grooves are not the correct diameter
17. The bore lands and/or grooves are rough or irregular
18. The bore finish is inconsistent
19. The rifling twist rate is incorrect for the bullet weight or velocity
20. The bolt/receiver locking lugs do not bear uniformly
21. Headspace is incorrect
22. The bolt face is crooked (not at 90° to bore/receiver centerline)
23. The firing pin port is oversize
24. The firing pin tip is undersize or off center
25. The bolt body is under diameter (places the firing pin port off center)
26. Firing pin protrusion is not correct
27. The firing pin tip is bent
28. The firing pin spring is too short

Barrel, Receiver, and/or Bolt Stress

29. The receiver is stressed by incorrect stock mounting (no metal-to-metal fit)
30. The receiver is stressed by stock pressure on the barrel
31. The receiver is stressed by incorrect scope mounting
32. M98 receiver ring is stressed due to thread compression (long secondary torque surfaces)
33. The barrel is stressed by stock pressure or receiver stock mounting
34. The barrel/receiver are stressed by crooked threads or untrue torque shoulders
35. The barrel/receiver are stressed by over torquing the barrel
36. The barrel was internally stressed during manufacture
37. The barrel was internally stressed or additionally stressed in manufacturer's straightening process
38. The barrel has been stressed by tweaking or bending
39. The receiver is stressed due to uneven bolt/receiver locking lug engagement
40. The bolt body is stressed due to uneven locking lug engagement

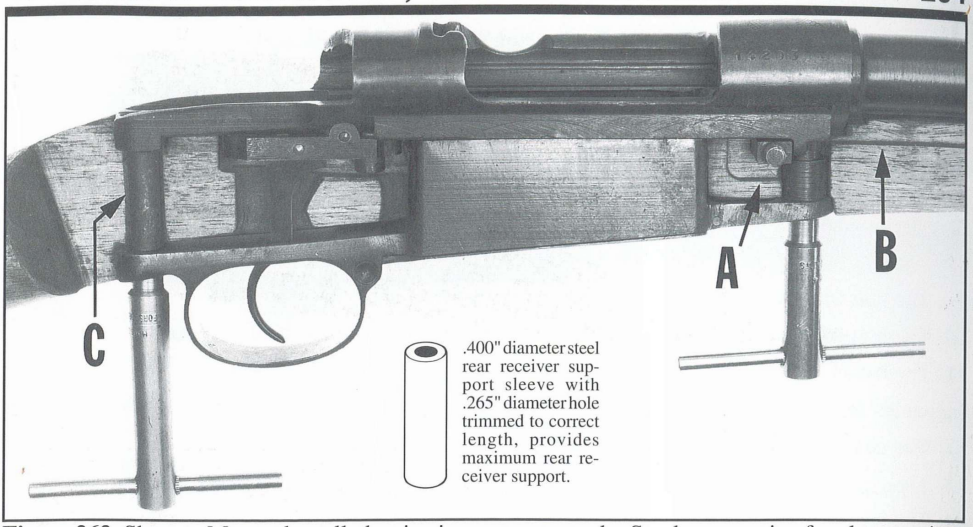


Figure 262- Shows a Mauser barrelled action in a cutaway stock. Stock preparation for glass receiver bedding can be easily seen in a cutaway stock. The illustration, at center, shows a .400" diameter steel rear receiver support sleeve. Stock preparation includes recessing the stock behind and under the stock crossbolt, shown at **A,** and about 3" further forward under the receiver ring and barrel, at **B**, to receive a thick layer of bedding compound. Stocks without crossbolts are recessed under the receiver and forward under the barrel in the same way. The difference is that the bedding compound directly supports the receiver recoil lug. The original hole in the stock for the rear receiver mounting screw and sheet metal sleeve is enlarged to make room for a larger diameter steel support sleeve, as shown above, and as much bedding compound as possible. Best stock bedding materials are **Brownells Acraglas** and **Brownells** (stainless steel filled) **Steel-Bed** bedding compounds. These excellent bedding compounds harden by chemical action and shrink less than 1/10th of 1%.

A properly bedded Mauser receiver actually rests on steel at both mounting screw locations. Receiver mounting screws cannot compress the stock and, in turn, flex and stress the receiver and barrel. The barrel, however, may still be stressed by forestock pressure, as discussed below.

I suggest bedding stocks in stages. This approach minimizes the risk of mechanical locking and actually takes less time, particularly when working with several rifles at once. The steel rear receiver support sleeve is first cut to the correct height, end trued on the lathe, and glassed into the stock at the rear receiver mounting screw hole. With this done, rear receiver position in the stock is established and the remaining bedding steps can be completed. Stocks with crossbolts are bedded in two additional steps: the crossbolt is bedded in next, followed by the barrel/receiver support area, shown at **B** above. Stocks that do not have crossbolts can be bedded in both areas at the same time. See front receiver and forestock bedding in figures 265 and 266. Additional stock bedding between the receiver mounting screws doesn't serve a useful mechanical purpose, but is sometimes done to cosmetically repair rough inletting jobs.

When the receiver is correctly bedded and the barrel is supported to approximately 3" forward of the receiver, the stock's barrel channel can then be clearanced to float the barrel. Elimination of forestock/barrel contact and pressure can improve accuracy in many hunting rifles. However, this doesn't work when the existing barrel is not concentric or has internal irregularities and/or internal stress problems. In many cases, barrels that are even moderately stressed internally can be vibration dampened at the front of the forestock to help overcome the effects of vibration and heating on the barrel. Upward stock pressure applied to the barrel (ranging from ounces to pounds) will stabilize lighter barrels in most short to medium range hunting rifles. See figure 266. When free floating and upward vibration dampening does not work, the barrel is either excessively stressed internally, nonconcentric, or has been machined and installed incorrectly. Always recheck previous work before replacing a barrel that doesn't group as it should on target.

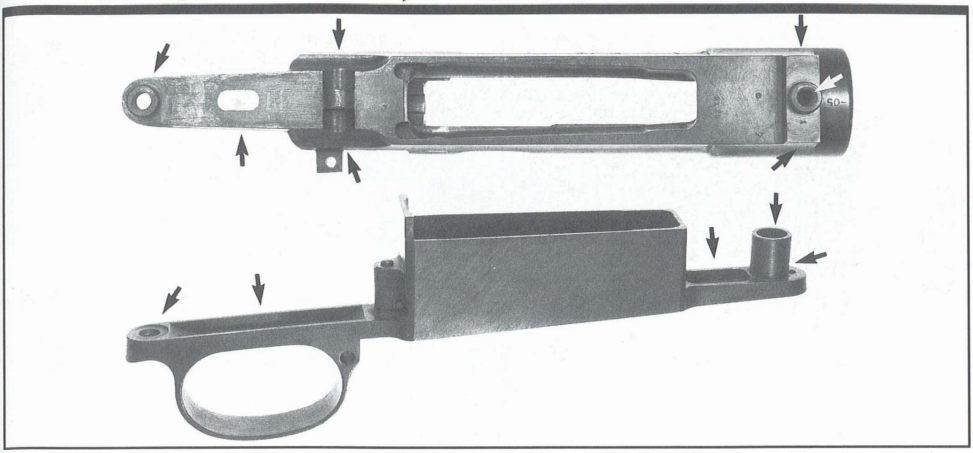


Figure 263- Shows an M98 receiver and trigger guard/magazine housing assembly. Arrows show points where the receiver and magazine/trigger guard housing are prepared or filled to prevent epoxy bonding or mechanical locking. Edges that are nicked or sharp or that would keylock and make removal of the receiver from hardened stock bedding compound difficult are levelled or chamfered. .010" paper spacers are rubber cemented to the sides and front of the recoil lug for receiver removal clearance. Recesses, slots, pinholes, low areas, etc., that might fill with epoxy are filled with modelling clay. Threads are greased and surfaces are then sprayed with mold release compound. Prevent bedding mishaps by closely examining the receiver and barrel for areas that might have been missed that would permit mechanical locking or epoxy bonding. Correct any problems and recoat with mold release compound before bedding.

Warning: Aerosol mold release compounds must be used only in a well ventilated area. Consult manufacturer's instructions before using. Avoid breathing vapors and contact with eyes and skin.

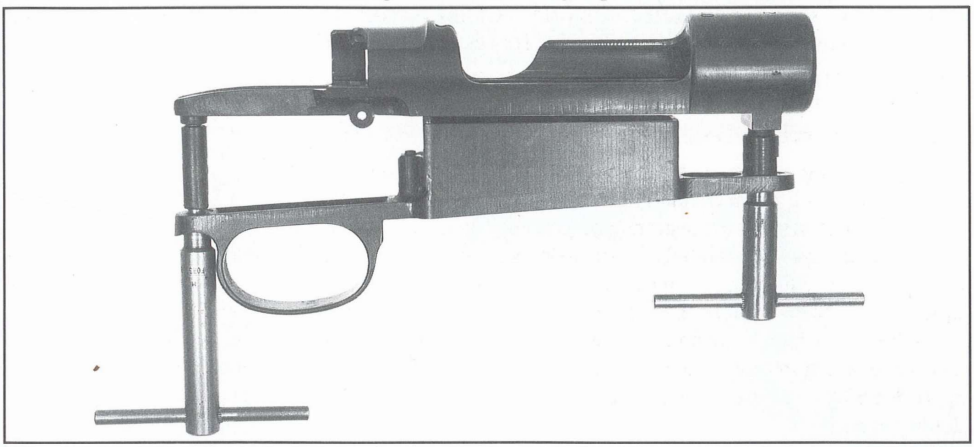


Figure 264- Shows an M98 receiver, trigger guard housing/magazine well, and rear receiver support sleeve set up in stockmaker screws in the same position as the action would be when bedded in a stock. In the bedding process, the installed trigger guard/magazine housing acts as a bottom dam. Modelling clay or other suitable sealing material can be used to prevent bedding epoxy from leaking or running out of the bedding locations, shown at arrows above. In severe cases, it can be virtually impossible to remove a barrelled action from a stock when bedding epoxy gets into threads, slots, or pin holes and/or bonds to the receiver, barrel, or magazine well and is allowed to set up. I have seen barrels bent by individuals who have tried to remove barrelled actions from stocks after epoxy bonding or mechanical locking. Bedding epoxy can also mechanically lock a barrelled action into a stock if allowed to set up above centerline of the barrel or receiver. Stockmaker's hand screws are sprayed with mold release compound and threads greased before installation.

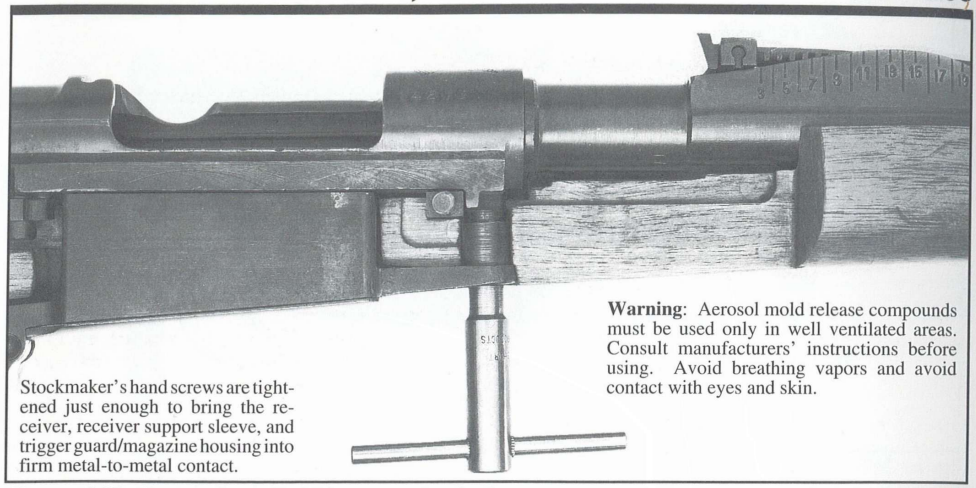


Figure 265- Shows a barrelled Mauser action in the cutaway stock shown earlier after the steel rear receiver support sleeve has been bedded in. The stock crossbolt can now be bedded in. The crossbolt and crossbolt nuts must be coated with mold release compound and installed before the bedding compound is poured in. Stocks without crossbolts can be bedded under the barrel support area. Place a clay dam at the end of the support area to prevent runout. Keep the rifle in a level position until the epoxy begins to harden. Bedding compound that is displaced upward past the stock line must be cut off with a plastic knife while it is still soft. Metal colored Steel-Bed compound should be measured very carefully to prevent upward displacement to stock line. When bedding epoxy reaches the semihard but still pliable state, play it safe by removing the barrelled receiver and TG/mag. housing from the stock. Recheck for mechanical lock and clearance any questionable area with an Exacto knife. Then, recoat barrel and receiver with mold release compound and reinstall in stock. Consult the manufacturer's instructions before using any bedding epoxy. Full curing time with the various compounds runs from several days to a week. For best results, do not fire the rifle for at least one week.

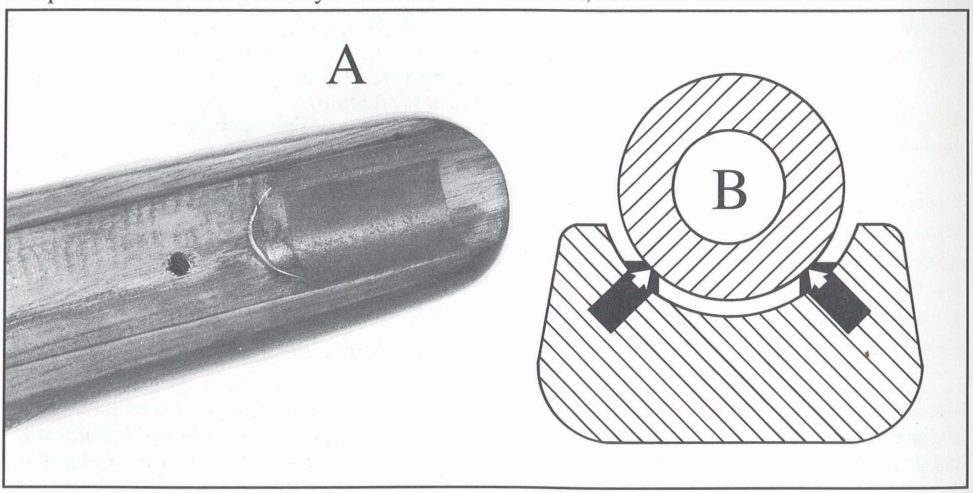


Figure 266- Shows two basic methods for dampening and stabilizing rifle barrels that do not perform well when free floated in a stock. Upward pressure is placed on the barrel to be reinstalled in the stock, shown at left, by glassing in a barrel tensioning shim, at **A**, near the end of the forearm. Actual thickness of the shim, and the barrel pressure needed, is determined by test firing the rifle and adjusting shim thickness on a trial and error basis. An alternate method, shown at **B**, also requires test firing, but uses two nylon or teflon tensioning pins which are hand adjusted to the length needed to stabilize the barrel. With either method, several ounces to several pounds of upward dampening pressure is used to stabilize the barrel to the extent that it can be stabilized.

About Metal Surface Finishing and Bluing-

The metal finishing methods discussed below require surface preparation beforehand and removal of machine marks, nicks, and scratches before final polishing to the desired appearance. Style and quality of surface preparation of the barrel, receiver, and other parts determines final appearance after bluing. Some polishing styles favor one bluing method more than another. Rust bluing, for example, is best done on low to semi-gloss surfaces. High gloss finishes should be hot oxide blued for best appearance. The following basically traditional metal finishing methods can be used on rifles that are to be rust blued, blued by the accellerated rust blue process, or hot oxide tank blued.

Barrels:

Final polish the barrel on the lathe with #400 sandcloth kept wet with oil. Hold sandcloth evenly and move slowly so that polishing lines are parallel and evenly spaced. This can be done on a lathe by hand or with a lathe mounted honing and polishing fixture as shown in figure 267. Make final passes with worn #400 sandcloth. This produces a low gloss, precision honed appearance.

Option A. The above barrel finish can be brightened by making several light polishing passes on the barrel with a soft, extra fine wire wheel after step **1**, above. This can be done with a lathe mounted wire wheel or by hand polishing the barrel on a soft wire wheel installed in a bench or floor mounted grinder or buffer. When barrels are hand held, wire wheel contact must be kept light and even while the barrel is moved slowly and rotated. Wire wheel polishing marks must be kept in parallel agreement with the sandcloth polishing lines on the barrel.

Option B. After lathe honing the barrel with #400 sandcloth, as above, final polish with an extra fine Scotchbrite flap wheel. This can be done on a lathe mounted polisher or on an extra fine Scotchbrite flap wheel installed in a bench or floor mounted grinder or buffer. Traditional sporter barrels look best when finished to a low or medium sheen with this, or a similar, method.

Receivers:

1. For Rust Bluing- After reheat treating, lightly repolish the exterior of the receiver above stockline on an extra fine Scotchbrite flap wheel. Do not buff through case hardening or pull or round off corners. Clean off any scum on the outside of the receiver below stockline with solvent and a bristle brush.

Option A. After ***step 1***, the receiver can be slightly dulled by striking and lightly etching surfaces with 32% hydrochloric acid diluted in 9 additional parts of distilled water. This step is done just before bluing and after the receiver has been completely cleaned and degreased. The acid solution should be applied to the exterior of the receiver with a clean cotton swab. The receiver will turn gray as etching begins. Leave acid in contact with the receiver just long enough to lightly etch and dull the outside surfaces. Do not immerse the receiver in the acid solution.
Warning: Use acids and caustics with extreme care. Always wear safety glasses, rubber gloves, and a rubber apron. Keep a container of clean water nearby to flush acid splatters.

2. For Oxide Bluing- After reheat treating, lightly repolish the exterior of the receiver above stock line on an extra fine Scotchbrite flap wheel. Do not buff through case hardening or pull or round off corners. Remove scum on the outside of the receiver below stockline with an extra fine wire wheel.

Option A. If the receiver was highly polished before reheat treating, repolish the exterior above stockline with #500 compound on medium and soft felt wheels. Detail hard to reach areas on the edge of a hard felt wheel and/or with felt bobs chucked in a Foredom tool.

Option B. If the receiver was polished with #400 compound before reheat treating, final polish surfaces with #400 compound, as in ***option A.***

Option C. If an extra high gloss finish is desired after polishing the receiver with #500 compound, as discussed in ***option A***, hand polish the receiver above stockline shoeshine style with denim strips and Simichrome metal polish. Polish hard to reach exterior areas of the receiver with Simichrome on a felt bob. Place the receiver in a hand polishing fixture as shown in figure 268 and mount in a bench vise for this work.

Except for ***option C***, these polishing methods and optional variations produce traditional low/medium sheen barrel/receiver metal finishes. When polishing is correctly done, metal surfaces will have a high quality, precision machined, and well honed appearance.

Receivers and other case hardened parts typically turn red when blued in a standard hot oxide bath. I suggest using Brownells Oxynate 7 bluing compound with Oxynate "S" heat treated steel additive to eliminate this problem.

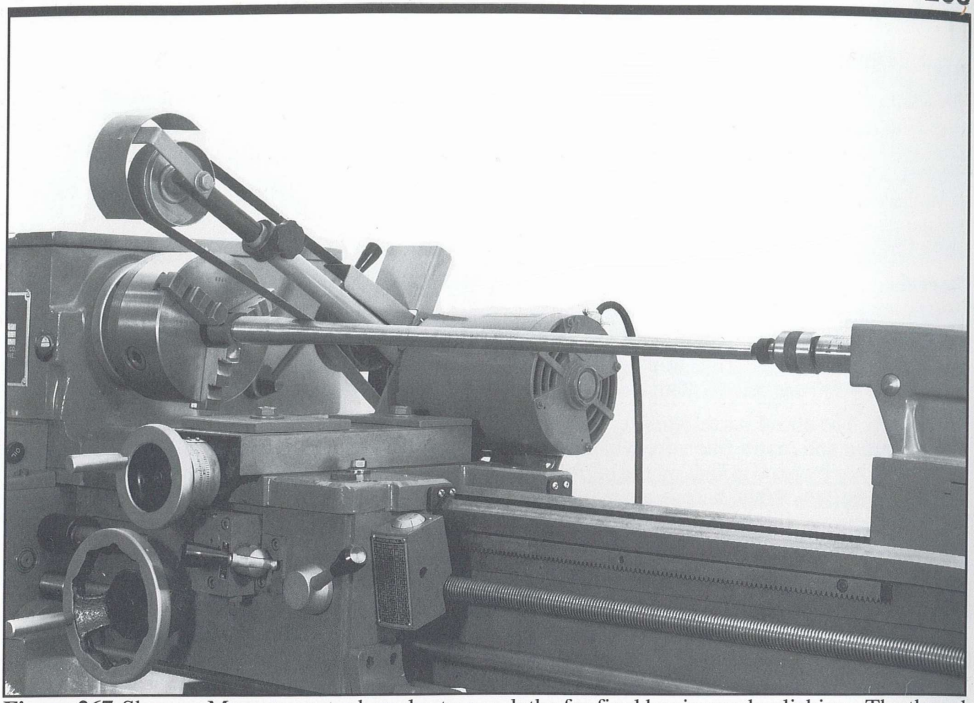


Figure 267-Shows a Mauser sporter barrel set up on lathe for final honing and polishing. The thread end of the barrel is lightly chucked in a threaded driving collar made from a piece of delrin or nylon. A tapered delrin or nylon barrel insert with a 60° center drilled end is used with a live center to protect the muzzle crown. Provide room for longitudinal barrel expansion by tightening the lathe chuck on the delrin driving collar just enough to turn the barrel. Bring in the live center just enough to keep the barrel turning on center. A crossfeed mounted belt sander is installed on the lathe. Lathe rpm and longitudinal feed rate are set to produce the desired honing effect. Adjust crossfeed (and sanding belt tension) so that the barrel is not heated beyond the ability of the setup to absorb the expansion. Prefinish the barrel with a #320 belt. Follow with a #400 belt. For a softer appearing surface, final finish with a worn #400 belt kept wet with oil. A lathe mounted polisher with an extra fine Scotchbrite flap wheel can be used to finish sporter barrels to a traditional low/medium sheen.

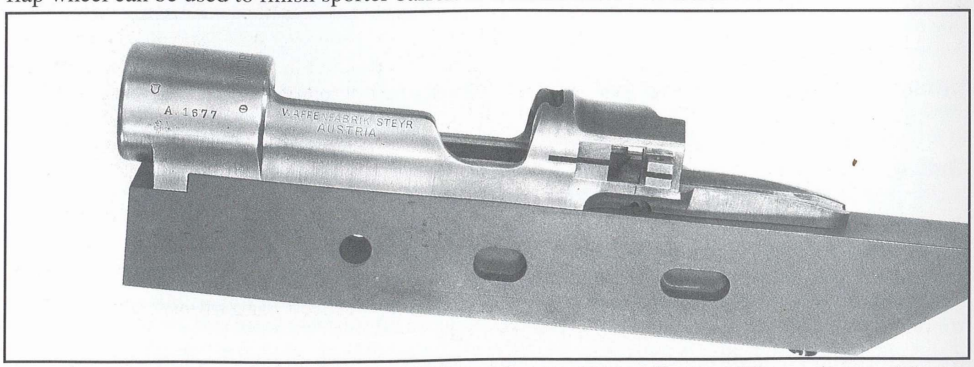


Figure 268- Shows an M98 receiver installed on a hand polishing fixture. The receiver and fixture are then installed in a bench vise to hand polish and detail the front ring, rear receiver bridge, and hard to reach areas. The receiver is secured to the fixture with 1/4"-22 Allen screws. Using a polishing fixture permits the receiver to be solidly mounted in a bench vise, addressed in almost every imaginable position with sandcloth, 3M Scotchbrite, metal polish, and/or felt polishing bobs, and eliminates the risk of squeezing or scarring the receiver.

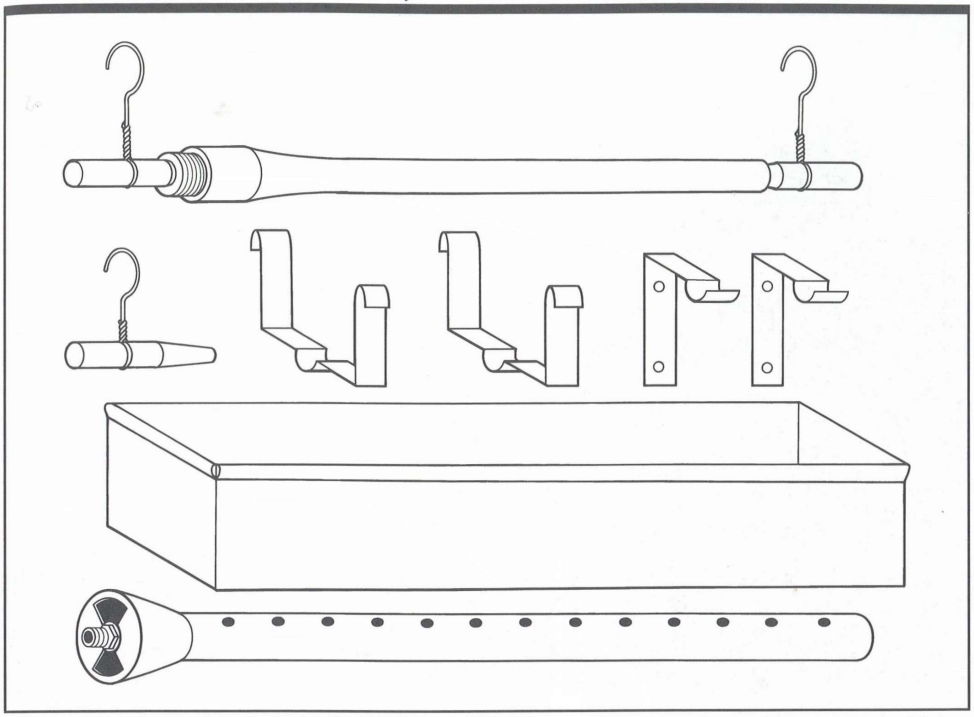


Figure 269- Illustration shows basic items needed for a professional accellerated hot water rust bluing room. Steel and fiberglass tanks, cleaning and bluing chemicals, gas burners, rubber gloves and materials discussed below are available from **Brownells, Inc**. Miscellaneous racks, holders, and brackets are made by the gunsmith. Although there is a mystique about hot water rust bluing, it is simply an old fashioned factory method that takes about the same time to learn as hot oxide bluing.

The accellerated hot water rust bluing process takes longer than hot oxide bluing, even when done on a production basis. However, there are several important advantages: metal repairs and surface irregularities are easier to blend in; case hardened and cast parts blue easier; final metal color is an old fashioned blue or dark blue rather than blue-black, and large quantities of expended caustic salts need not be neutralized and disposed of.

The accellerated hot water rust bluing data given here is based on the author's experience with several bluing formulas as well as Brownells Dichropan IM. The professional shop procedure that follows is used to hot water rust blue Mauser bolt action rifles on a production basis, using **Brownells new formula Dichropan IM**. Mauser receivers and barrels that are prepared as discussed on page 207 and carefully blued with this method take on a quality, deep blue traditional appearance. Consult Brownells Inc. for full instructions or supplemental instructions for bluing small quantities of parts with only a single tank.

Note: Receivers and barrels that are to be rust blued by either the accellerated hot water bluing method or the slower damp box method should be assembled and torqued after bluing has cured. Receivers and barrels that are to be blued by the hot oxide process should be assembled and torqued before bluing.

1. Run an oiled patch through bores and chambers and drive tapered, tight fitting hardwood dowel plugs into the chamber and muzzle ends of barrels.
2. Wipe off all oil on barrels, receivers, and parts to be blued with soft shop cloths. Then degrease with trichloroethane.
3. Install black iron tie wire loop handles on dowel plugs in barrels and wire hooks on receivers and balance of parts. Hooks must be easily removed or bent away for carding and must not contact finished exterior surfaces.

Production Accellerated Hot Water Rust Bluing Process, Continued-

4. Make sure all processing tanks are completely clean before filling and use.

Note: At least five tanks are needed to hot water rust blue barrels, receivers, and parts on a production basis. Mild steel tanks are needed for the 180°F hot cleaning solution and the boiling water bluing process tank. Fiberglass tanks can be used for the cold precleaning solution, cold water rinse, and the water displacing oil/curing bath. A tank is not suggested for the acid strike step discussed below and on page 207.

Warning: If acid gets past the barrel dowel plugs, it will etch and damage the bore and/or chamber.

5. Prepare the processing tanks as follows:

A. Bring the hot cleaning solution to 180°F and adjust the burner to hold temperature. Do not boil this solution. **Brownells Dichroclean 909** is an excellent cleaner for this purpose.

B. Bring the hot water bluing process tank to a low/medium boil and set the burner to maintain this level of boil. Distilled or deionized water should be used if local water supply causes bluing problems.

C. Fill the cold precleaner tank about half full with a commercial ammoniated cleaner. Use only cleaners that do not contain water based waxes or other chemicals that would coat steel surfaces and/or otherwise interfere with the bluing process. Before using any cleaner, test by running old parts or pieces of mild steel through the bluing process.

D. Set up the cold rinse tank with one end raised about 1" so that running water will overflow into the drain at the low end. This flows oily residue that rises to the surface out of the tank. Water is turned off when the last part has been rinsed.

E. Fill the water displacing oil tank about 2/3 full. Parts are suspended in this tank at the end of the bluing process to pick up remaining moisture.

6. Begin the bluing process with one part at a time. Start by immersing parts in the cold cleaning solution tank and scrubbing with bristle brushes.

7. Cold water rinse the precleaned parts under running water (not in the rinse tank). Inspect for areas that pull back or still look oily. Reclean if necessary.
Caution: Do not touch parts with fingers past this point. Skin oils and/or acids can mark steel surfaces and interfere with the bluing process.

8. If the precleaned part looks O.K., suspend the part in the hot cleaning solution tank. Usually, when parts are precleaned, a few minutes in this tank will more than do the job. However, if rinse water on a part pulls back or the part caused an oil slick on the cold rinse water, put it back in the hot cleaning solution tank for an additional 10 or 15 minutes.

9. Take the part out of the hot cleaning solution and place in the cold water rinse tank. Scrub the part with a bristle brush and rinse until the slick residue from the hot cleaning solution is gone.

10. Acid strike. (This is an optional step- see page 207.) Acid striking is done for either of two reasons: when all or part of a receiver would not "take" and blue correctly on a previous bluing run due to surface variations in the steel; or when a slightly softer, etched receiver finish is desired.
Parts that are to be run through again must be repolished. Strike by coating the surfaces evenly with a large very wet swab. Do not immerse barrels, receivers, or parts in an acid bath. Do not permit leaf or coil springs to contact acid.

11. After acid striking, rinse in cold running water to neutralize the acid on the part.

12. Suspend the cleaned part (or cleaned and acid struck part) in the boiling water process tank for 5 or 6 minutes.

13. Remove the part, shake off excess water, and hang the part on the process rack until 100% dry. Do not touch parts from here on until the end of the bluing process, even with rubber gloves, unless both the part and the rubber gloves are 100% dry.

Production Accellerated How Water Rust Bluing Process, Continued-

14. When the part is 100% dry, a light orange natural rust will usually be apparent on the surface. Card and scrub the surface with #1 steel wool that is 100% clean, degreased, and dry. Slight variations in surface color may be seen at this time. These almost always tone-in later with successive applications of bluing solution. Steel wool can be degreased in trichloroethane.

15. Pour a small amount of bluing solution in a clean glass container at this time. Apply bluing solution to the part with a large cotton swab.

Note: This is where most rust bluing solutions are completely unforgiving. Streaks and runs, particularly in the first application, can produce permanent lines and/or variations in the final finish. Runs and streaks are almost never a problem with Brownells Dichropan IM. Brownells suggests swabbing a liberal amount of Dichropan IM on each part to be blued for one minute and making sure that the entire part gets as much solution on it as possible. See Brownells instructions.

16. Then, suspend part in boiling water process tank again. Leave in boiling water for five minutes.

17. Remove the part from the tank, shake off excess water, place the part on the process rack, and allow the part to 100% air dry.

18. Card off the red/brown residue on the part with 100% clean, degreased, and dry #1 steel wool and/or on a fine, soft wire wheel that also is clean, degreased, and dry. A well carded steel surface will take on a gray or blue-gray tone at this point. Card slightly discolored areas until blended in as much as possible. Remaining color irregularities caused by differences in the metal surface, variable carbon absorption, etc., will usually tone-in after several applications of bluing solution.

Caution: The red/brown residue being carded off or still on the part (whether visible or not) is chemically active when wet. If moisture of any kind, including a drop of sweat, gets on the part, on the gloves, or into the residue and back onto the part, the surface of the part will be permanently spotted. If this happens, take the part out of the bluing sequence, repolish, and start over. Always throw away the small amount of solution and swab used for the first application of bluing solution. Also dispose of the steel wool used to card off the surface of the part after the first application step. Remaining first stage residue can attack and damage the surface of a part at the second solution application and carding.

19. Repeat steps 15 through 18 until the desired surface color and darkness is reached. This usually takes about five to seven solution applications and cardings. Use a new batch of bluing solution in a clean glass container and clean cotton swabs for the second application through the remainder of the process.

20. After the last carding, wipe off parts with a soft cotton cloth and suspend in the water displacing oil tank. Pull dowel plugs, slip a copper wire through the bore, and suspend barrels in the water displacing oil tank next to parts. Leave the parts immersed in the oil tank for about thirty minutes.

21. Remove the parts from the water displacing oil tank, leave wet with oil, and place on the curing rack. Leave parts to oil cure for about twenty four hours. Small remaining variations in tone will usually blend in during the oil curing process.

22. After oil curing, wipe and rub down parts with a soft, clean cotton cloth. Then protect with a light coat of gun oil.

23. Lightly polish the barrel crown and rear barrel face with #600 sandcloth. Use care to protect the finish on the barrel.

Warning: Always wear safety glasses, a rubber apron, and rubber gloves when handling or using solvents and chemicals. Always consult manufacturer's instructions and warnings before using solvents and chemicals. Use solvents and chemicals only in a well ventilated area. Consult local regulations and neutralize acids and caustics before disposal.

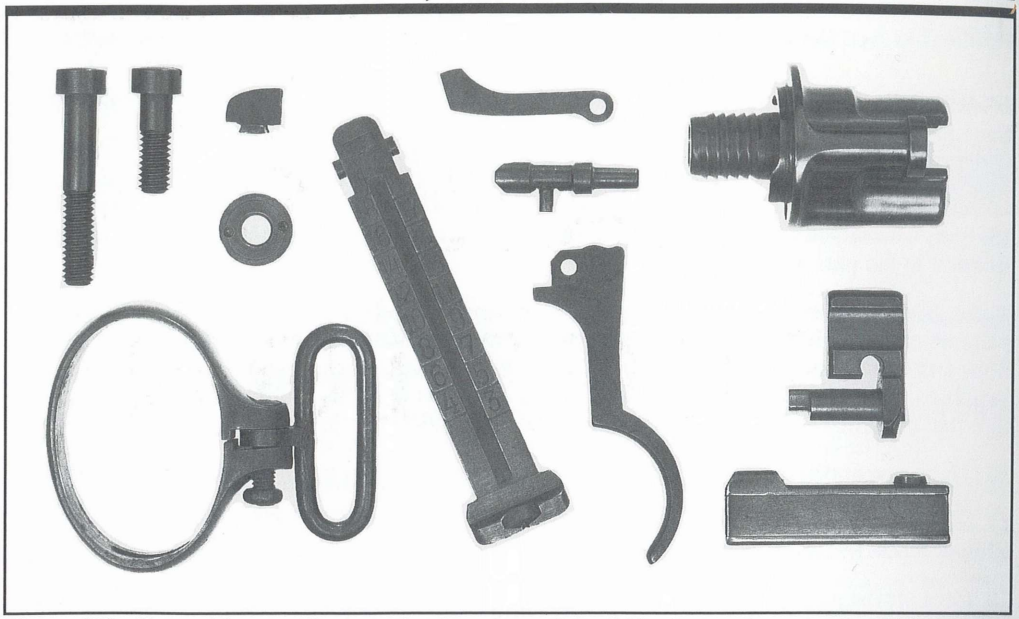


Figure 270- Shows Mauser rifle parts that have been "nitre" blued at various purple and blue range temperatures. Nitre bluing is the old name given to recoloring parts in a molten potassium nitrate or mixed nitrate/nitrite bath. The original color on many heat treated small steel parts was the visual index of the temperature at which temper was drawn. Steel parts can be blued in a molten nitrate bath to give them a traditional, turn of the century appearance. This is particularly useful in restoring earlier Mauser rifles. **Nitre Bluing Compound**, available from **Brownells, Inc.**, melts at 275°F.

Highly polished carbon steel parts take on beautiful blues, purples, or straw colors when immersed in a molten nitrate salts bath. The molten nitrate salts must be stabilized in the temperature ranges given below to produce predictable results. A 1000° lead bath heat treating thermometer is used in checking and adjusting nitrate bath temperatures.

Carbon Steel Temperature/Color Table

Carbon Steel Surface Color	Salts Temperature Degrees Fahrenheit	Salts Temperature Degrees Centigrade
Faint Pale Yellow	430	221.1
Light Yellow	440	226.7
Light Straw Yellow	450	232.2
Straw Yellow	460	237.8
Full Straw Yellow	470	243.3
Dark Yellow	480	248.9
Yellow Brown	490	254.4
Brown Yellow	500	260.0
Spotted Purple Brown	510	265.6
Brown Purple	520	271.1
Light Purple	530	276.7
Full Purple	540	282.2
Dark Purple	550	287.8
Full Blue	560	293.3
Dark Blue	570	298.9
Blue Black	600	315.6
Blue Gray	620	326.7
Light Blue	640	337.8

Factors that control the final color of steel parts:

1. The temperature of the molten nitrate bath
2. The chemical composition of the steel
3. The length of time the part is in the bath
4. The style of finish on the part

Warning: Molten nitrate salts must be used with extreme care. Wear protective clothing. Use only with power ventilation, Cyanides and acids must not come in contact with the bath. Keep quenching water far enough away so that if it splashes or splatters, it will not cause the bath to splash or splatter and cause serious burns to the face. Consult manufacturer's instructions before use.

PARTS SECTION

U. S. sources for Mauser M91~M98 action parts

Springfield Sporters, Inc.
RD 1
Penn Run, PA 15765

Gun Parts Corporation (G.P.C.)
Williams Lane
West Hurley, NY 12491

Century International Arms, Inc.
80 No. Main St.
St. Albans, VT 05478

The M98 exploded parts illustrations on pages 217 and 218 were drawn by V S P staff artists based on an original single drawing by Shelley Braverman. Rights to the original Braverman drawing courtesy- Publishers Development Corp. with special thanks to Jerry Lee, Editor, GUNS Magazine. Because similar parts drawings were not available, the following exploded parts illustrations were drawn in the same style by V S P staff artists: the M94/M96 Swedish Mauser action on page 219, the M93/M95 Spanish Mauser action on page 220, and the M91 Argentine Mauser action on page 221. These stylized drawings are supplied for general reference and parts identification, and are not exact representations or to scale.

Mauser Action Dimension Table With Considerations for Use in Building Custom Rifles

Action Model & Manufacturer	*Action Type and Size*	*Action O.A.L.*	*Receiver Screws*	*Bolt Body Length*	*Magazine Length*	*Large Ring dia*	*Small Ring dia*
Standard Modell Mauser, Oberndorf	*M98/Standard*	*8.750"*	*7.835"*	*6.370"*	*3.315"*	*1.410*	—
M1935 Peruvian FN, Belgium	*M98/Standard*	*8.750*	*7.835*	*6.370*	*3.315*	*1.410*	—
M1924/30 Venezuelan FN, Belgium	*M98/Standard*	*8.750*	*7.835*	*6.370*	*3.315*	*1.410*	—
M1909 Argentine DWM	*M98/Standard*	*8.750*	*7.835*	*6.370*	*3.315*	*1.410*	—
M1908 Brazilian, DWM	*M98/Standard*	*8.750*	*7.835*	*6.370*	*3.315*	*1.410*	—
VZ-24 Brno, Czechoslovakia	*M98/Standard*	*8.750*	*7.835*	*6.370*	*3.315*	*1.410*	—
VZ-33 Brno, Czechoslovakia	*M98/Standard*	*8.750*	*7.835*	*6.370*	*3.315*	—	*1.300*
G33-40 Czech-Brno	*M98/Standard*	*8.750*	*7.835*	*6.370*	*3.315*	—	*1.300*
M1908/34 Brazilian Brno, Czechoslovakia	*M98/Standard*	*8.750*	*7.835*	*6.370*	*3.315*	*1.410*	—
KAR 98 Erfert, Danzig	*M98/Standard*	*8.750*	*7.835*	*6.370*	*3.315*	—	*1.300*
M1954 Brazil	*M98/Standard*	*8.750*	*7.835*	*6.370*	*3.435*	*1.410*	—
M1909 Peruvian Oberndorf	*M98/Intermediate*	*8.750*	*7.835*	*6.165*	*3.115*	*1.410*	—
M24 Mexican FN, Belgium	*M98/Intermediate*	*8.500*	*7.620*	*6.165*	*3.232*	*1.410*	—
M24, 47,48 FN or Yugoslavia	*M98/Intermediate*	*8.500*	*7.620*	*6.115*	*3.232*	*1.410*	—
Commercial Oberndorf	*M98/Intermediate*	*8.750*	*7.835*	*6.165*	*3.115*	*1.410*	*1.300*
M1935 Argentine	*M98/Intermediate*	*8.750*	*7.835*	*6.165*	*3.115*	*1.410*	—
M1910 Mexican FN, Mexico	*M98/Intermediate*	*8.500*	*7.620*	*6.080*	*3.118*	—	
M1936 Mexican FN, Mexico	*M98/Intermediate*	*8.500*	*7.620*	*6.080*	*3.118*	—	*1.300*
VZ 47 Commercial Brno, Czechoslovakia	*M98/Standard*	*8.750*	*7.835*	*6.370*	*3.315*	—	*1.300*
Commercial Husqvarna	*M98/Standard*	*8.750*	*7.835*	*6.370*	*3.400*	—	*1.300*
ZG 47 Commercial Brno, Czechoslovakia	*M98/Standard*	*8.750*	*7.835*	*6.370*	*3.400*	—	*1.300*
Commercial FN , late model	*M98/Standard (.30-06 Length)*	*8.750*	*7.835*	*6.370*	*3.400*	*1.410*	—
Commercial Magnum	*M98/Long*	*9.150*	*7.835*	*6.770*	*3.640/3.840*	*1.410*	—
Commercial Magnum Brevex-France	*Brevex/Long*	*9.240*	*8.207*	*6.740*	*3.900*	*1.500*	—
Commercial KURZ	*M98/True Short*	*8.125*	*7.225*	*5.760*	*2.725*	—	*1.300*
M1894/96 Swedish Carl Gustafs	*M94/Standard*	*8.500*	*7.620*	*5.630*	*3.240*	—	*1.300*
M1893-M1895 Various Mfg.	*M93/Standard*	*8.500*	*7.620*	*5.550*	*3.125*	—	*1.300*

Table data provided by John Vest and James L. Wisner. John Vest is a firearms engraver, stockmaker, and instructor at Lassen College Gunsmithing School. He is a charter member of the Firearms Engraver's Guild of America and member of the American Custom Gunmaker's Guild. James L. Wisner owns Precise Metalsmithing Enterprises, a manufacturer of high quality scope rings and bases, custom rifle accessory items, and reproduction pre-1964 Winchester Model 70 parts. He is also a member of the American Custom Gunmaker's Guild. Although intermediate and special 7x57mm length M98 actions are often referred to as "short", they are not. True M98 short (kurz) actions are actually 8.125" long. Intermediate actions are identified primarily by bolt body length (6.115" & 6.165") and magazine well length (usually 3.115" to 3.118").

Mauser Action Dimension Table With Considerations for Use in Building Custom Rifles, Continued-

Action Model & Manufacturer	*Barrel Shank*	*Firing Pin Length* O.A.*	*Rear*	*Front*	*Comments*
Standard Modell Mauser, Oberndorf	*1.100*	*W 7.337*	*5.353*	*1.984*	*Banner marked. Highly desirable for building custom rifles*
M1935 Peruvian FN, Belgium	*1.100*	*W 7.337*	*5.353*	*1.984*	*Some were arsenal converted to .30-06*
M1924/30 Venezuelan FN, Belgium	*1.100*	*W 7.365*	*5.353*	*1.982*	*Highly desirable for building custom rifles*
M1909 Argentine DWM	*1.100*	*W 7.337*	*5.353*	*1.984*	*Desirable for factory hinged floorplate*
M1908 Brazillian DWM	*1.100*	*W 7.337*	*5.353*	*1.984*	*Highly desirable for building custom rifles*
VZ-24 Brno, Czechoslovakia	*1.100*	*W 7.337*	*5.353*	*1.984*	*Highly desirable for building custom rifles*
VZ-33 Brno, Czechoslovakia	*.980*	*W 7.337*	*5.353*	*1.984*	*Highly desirable for building custom rifles*
G33-40 Brno, Czechoslovakia	*.980*	*W 7.337*	*5.353*	*1.984*	*Highly desirable for building lightweight custom rifles*
M1908/34 Brazilian Brno, Czechoslovakia	*1.100*	*W 7.337*	*5.353*	*1.984*	*Similar to VZ 24 with Brazilian crest*
KAR 98 Erfert, Danzig	*1.100*	*W 7.337*	*5.353*	*1.984*	*Small ring + large thread = thin receiver wall Not recommended for magnums. 1 3/4" T.G. bow*
M1954 Brazilian	*1.100*	*W 7.337*	*5.353*	*1.984*	*Caution- some Brazilian made 98's are brittle! .30-06 caliber or converted 1908 models*
M1909 Peruvian Oberndorf	*.980*	*W 7.345*	*5.355*	*1.990*	*Have been made into small ring actions (Not recommended)*
M24 Mexican FN, Belgium	*1.100*	*W 7.208*	*5.225*	*1.983*	*Highly desirable for building custom rifles*
M24,47,48 FN or Yugoslavia	*1.100*	*W 7.240*	*5.225*	*2.015*	*Safety breeched version. Many receiver rings are not marked*
Commercial Oberndorf	*.980*	—	—	—	*Most were 7x57mm large or small ring. Large rings basically same action as 1909 Peruvian*
M1935 Argentine	*.980*	—	—	—	*Basically the same as M1909 Peruvian*
M1910 Mexican FN, Mexico	*.980*	*WO 7.036*	*5.306*	*1.730*	*Desirable for building lightweight custom rifles*
M1936 Mexican FN, Mexico	*.980*	*WO 7.036*	*5.306*	*1.730*	*Desirable for building lightweight custom rifles. Has pull knob on cocking piece*
VZ 47 Commercial Brno, Czechoslovakia	*.980*	*W 7.328*	*5.345*	*1.983*	*Has no guide rib on bolt. Expensive , but desirable for building custom rifles*
Commercial Husqvarna	*.980*	*WO 7.358*	*5.436*	*1.922*	*Improved Mauser such as M3000, M4000, Husky 5000, and JC Higgins M51L*
ZG 47 Commercial Brno, Czechoslovakia	—	—	—	—	*Commercial production. Has integral 3/4" dovetails on ring and bridge*
Commercial FN , late model	*1.100*	*W 7.365*	*5.355*	*2.010*	*FN made JC Higgins M50, early SAKO & Husqvarna MK X, Herters J9, Santa Barbara. Early production has C ring*
Commercial Magnum	*1.100*	—	—	—	*.404 Jeffery rarely available. .416 Rigby*
Commercial Magnum Brevex-France	*1.141*	*WO 7.760*	*5.590*	*2.170*	*Manufactured in France*
Commercial KURZ	*.980*	—	—	—	*Essentially a collector's item. Rarely available*
M1894/96 Swedish Carl Gustafs	*.980*	*WO 7.185*	*5.443*	*1.742*	*Designed for low pressure cartridges only Cocks on closing No third lug on bolt*
M1893-M1895 Various Mfgs.	*.980*	*WO 6.826*	*5.144*	*1.682*	*Designed for low pressure cartridges only Cocks on closing No third lug on bolt Spanish mfg. receivers are typically soft*

**Firing pin length designation "W" or "WO" means with or without safety lug shoulders on the firing pin spring retainer flange. Firing pin dimensions were obtained by measuring a good many firing pins because blueprint data is no longer available. Considerable dimensional variation was found when parts were measured. The reader should expect to experience the same.*

***Editor's Note**: This table is furnished to help identify Mauser M98 receivers, bolts, and firing pins. M93/M95 and M94/M96 data is included for comparison. It is important to note that other variations were manufactured.*

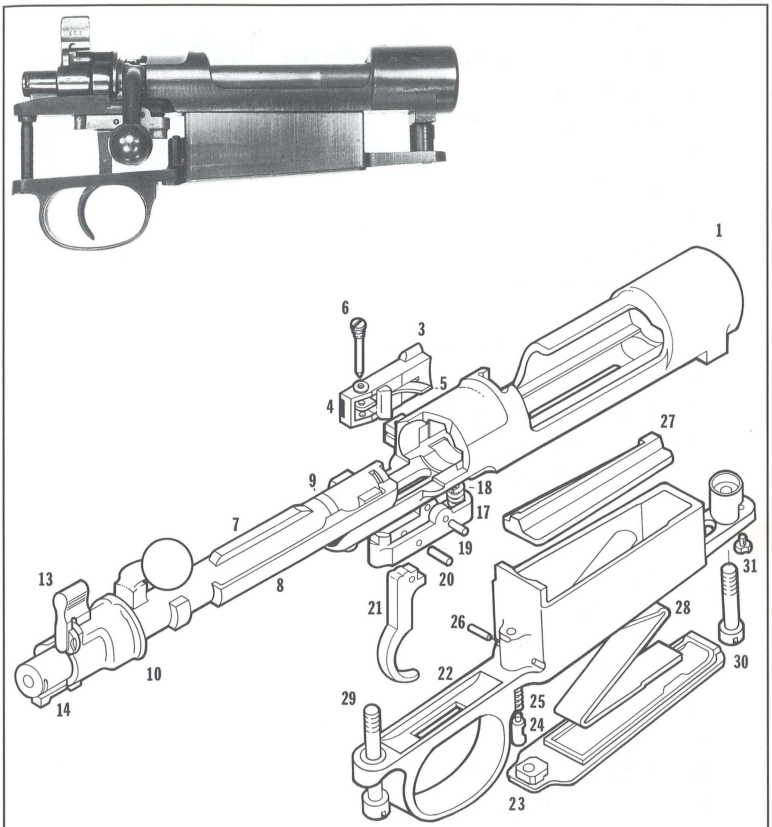
Parts Description

1. Receiver
2. Barrel/Barrel Assembly (Not Shown)
3. Ejector Box
4. Ejector Box Spring
5. Ejector Arm
6. Ejector Box Pivot Screw
7. Bolt Body
8. Extractor
9. Extractor Ring
10. Bolt Sleeve

10A Bolt Sleeve, Late Commercial Sporter

11. Bolt Sleeve Plunger
12. Bolt Sleeve Plunger Spring
13. Firing Pin Safety Lever
14. Cocking Piece
15. Firing Pin
16. Firing Pin Spring
17. Sear
18. Sear Spring
19. Sear Pivot Pin
20. Trigger Pivot Pin
21. Trigger
22. Trigger Guard Magazine Housing
23. Magazine Floorplate
24. Magazine Catch Plunger
25. Magazine Catch Plunger Spring
26. Magazine Catch Plunger Pin
27. Magazine Follower
28. Magazine Follower Spring
29. Assembly Screw, Front
31. Lock Screw

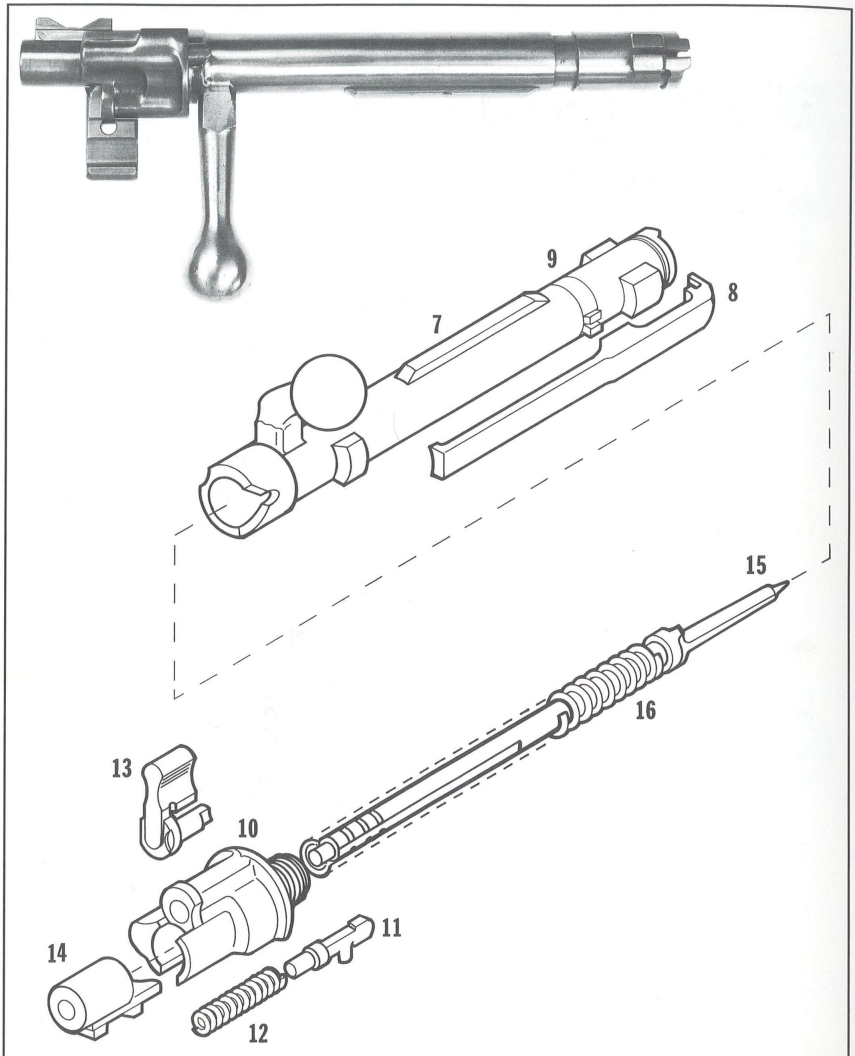
Mauser M98 Military Action
Standard Chamberings
7.9x57mm, 7.65x53mm, and 7x57mm



Drawing is general and not to scale

Figure 271- Shows exploded parts diagram for Mauser M98 military action.

Mauser M98 Military
Bolt Assembly

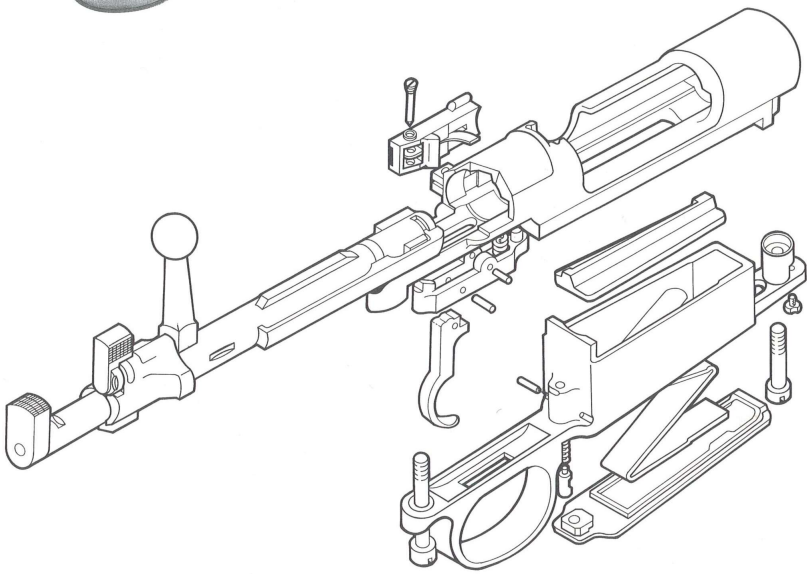


Drawing is general and not to scale

Figure 272- Shows exploded parts diagram for Mauser M98 military bolt.

Mauser M94 and M96 Swedish
Standard Chambering
6.5x55mm

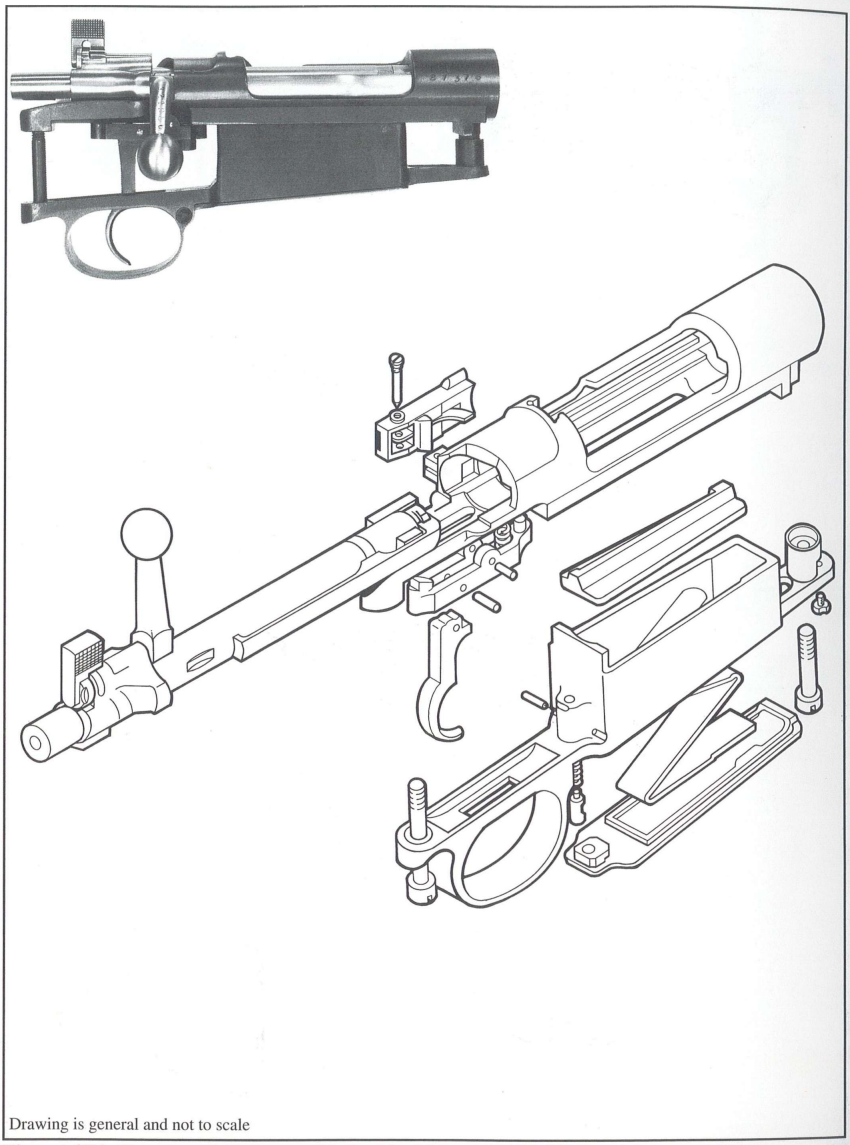




Drawing is general and not to scale

Figure 273- Shows exploded parts diagram for Mauser M94/M96 Swedish type action.

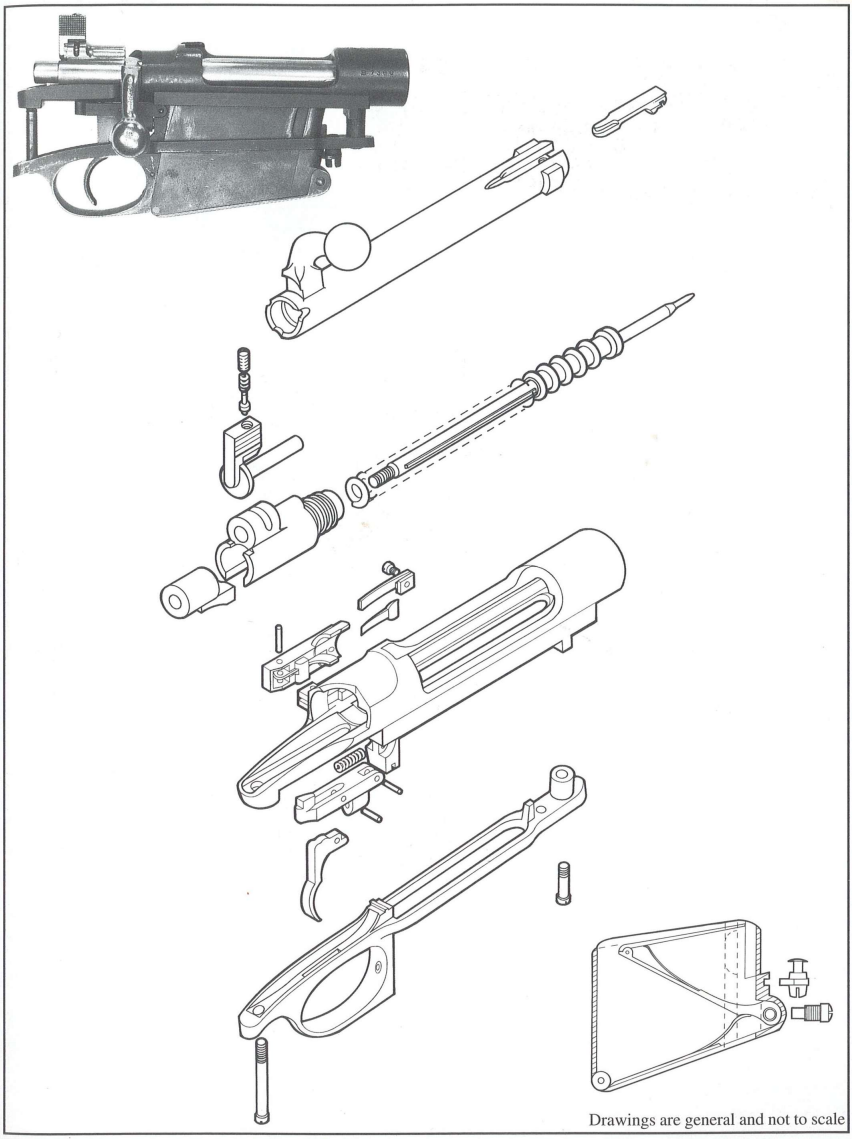
Mauser M93 and M95 Spanish
Also M94 (non Swedish)
Standard Chambering
7x57mm



Drawing is general and not to scale

Figure 274- Shows exploded parts diagram for Mauser M93/M95 Spanish type action.

Mauser M91 Argentine
(M91 Spanish similar)
Standard Chambering
7.65x53mm



Drawings are general and not to scale

Figure 275- Shows exploded parts diagram for Mauer M91 Argentine type action.

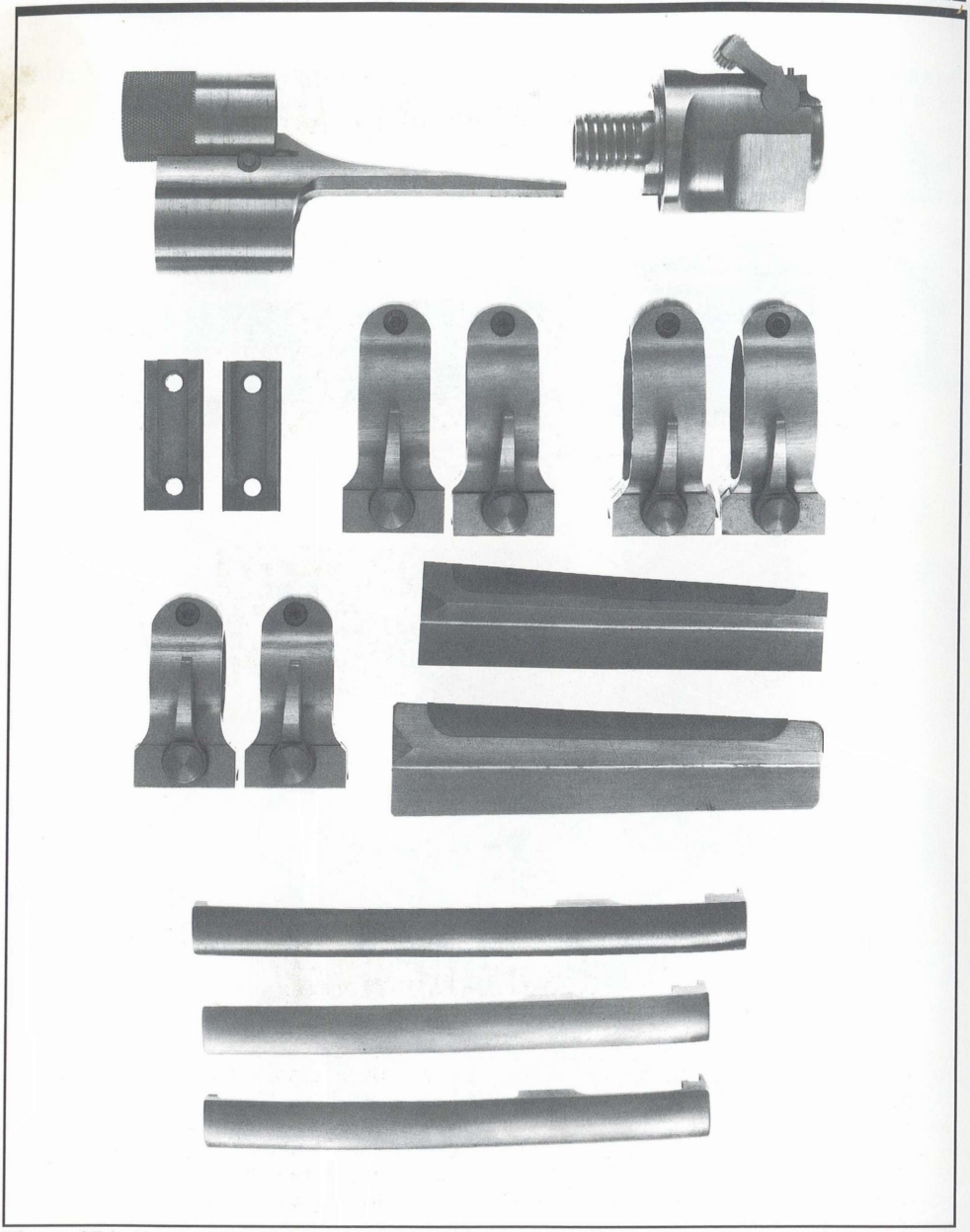


Figure 276- Shows Mauser and custom rifle accessory parts and Kimber Brownell style dovetail mounted, lever lock scope rings and matching dovetail bases manufactured by **Precise Metalsmithing Enterprises**. These items are furnished in the white for final finishing by the gunsmith. The classic streamlined bolt sleeve with side swing three position M70 style safety, at upper right, is superbly machined and is available for M98, Mark X, and several other popular actions. Gunsmith fitting is required. Band style sight ramps are made in thirteen hole diameters from .500" to .945" and are available with or without dovetail or hood cuts. Special sizes are available on request. M98 Mauser extractors are made in original 4.65" magnum length and also in Mexican Mauser and HVA Mauser sizes. Magnum cartridge size M98 magazine followers are unfinished and require fitting by the gunsmith. These high quality items are available from Brownells, Inc. or Precise Metalsmithing Enterprises.

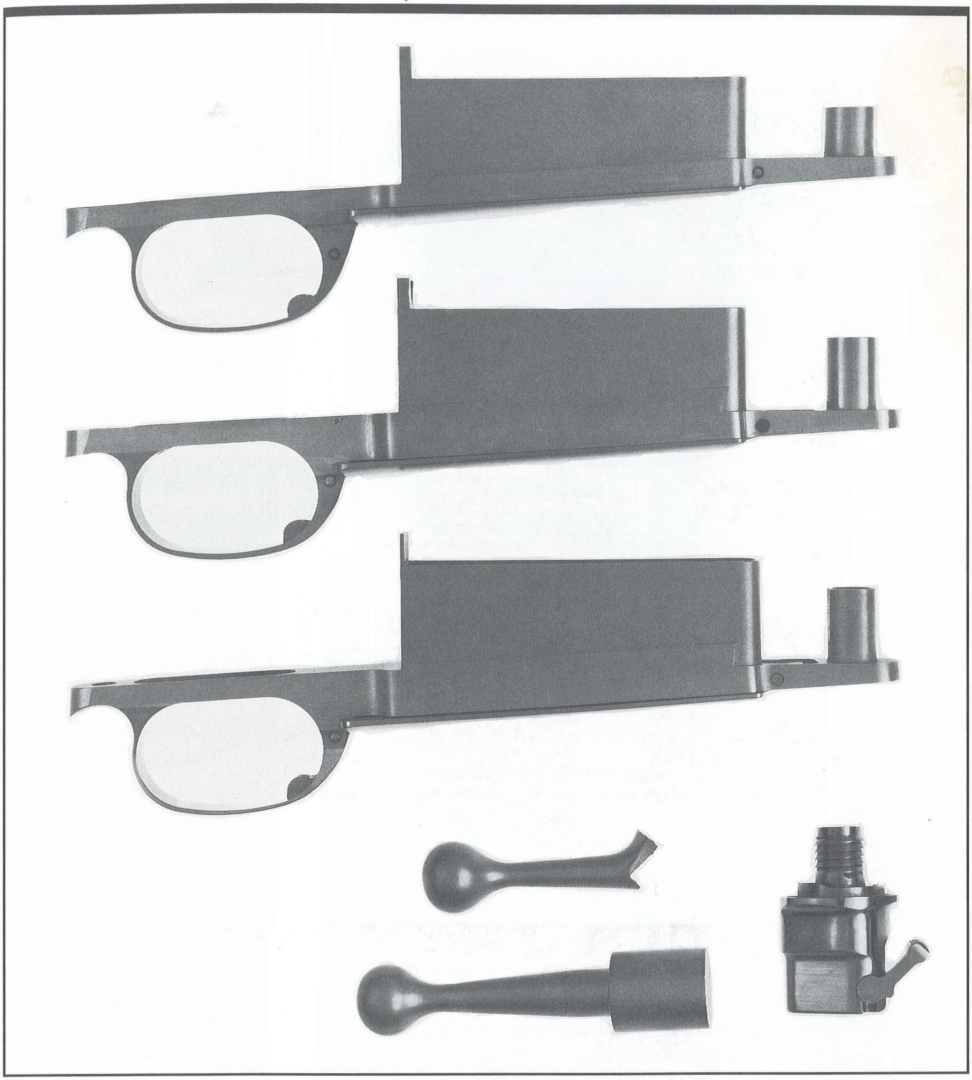


Figure 277- Shows Mauser commercial M98 sporter style trigger guard/magazine housings, at top, designed by Pete Grisel and manufactured by Dakota Arms, Inc. The hinged Oberndorf type floorplates are released by pushing the button inside the trigger guard. The three variations shown all have standard 7.835" receiver mounting screw hole centers. The #1640 has a magazine box length of 3.390" for .30-06 length cartridges. The #1660 has a considerably wider 3.400" magazine box for short magnum cartridges. The #1670 has a 3.620" magazine box for .300 and .375 H&H magnum length cartridges. Also shown are the Dakota streamlined commercial Mauser bolt sleeve with M70 style three position side mounted safety lever, Mauser commercial style bolt lever, and long shank teardrop shaped bolt lever. Extra material is left at one end of the long shank bolt lever to permit chucking in the lathe for adjusting the final contour.

The author suggests that the #1670 trigger guard/magazine housing be used only on factory Mark X, Whitworth, or similar standard length M98 receivers that are factory made to accommodate .300 and .375 H&H magnum length cartridges. **Warning**: Altering a standard length military or commercial M98 receiver by removing steel from behind the bottom receiver lug to accommodate a longer than .30-06 length magazine box and make the action feed .300 or .375 H&H cartridges weakens the receiver. This modification is potentially dangerous in carbon steel military and early production Mauser commercial receivers.

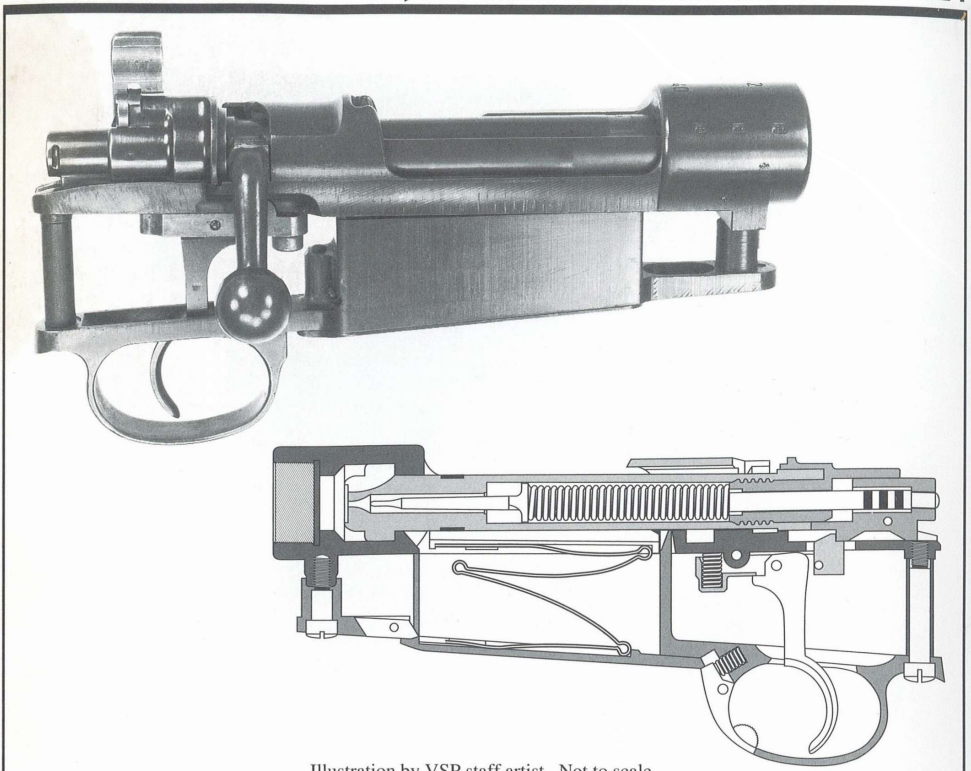


Illustration by VSP staff artist. Not to scale.

Figure 278- Shows views of the venerable Mauser M98 action, developed when metallurgy, particularly in the brass cartridge case manufacturing process, could not begin to approach the consistency that is possible today. The M98 action was developed during a time when blown cartridge cases and case head separations were quite common. Paul Mauser elected the simplest, most logical solution which was to design a practical, common sense rifle action with features that overcame the existing state of the brass metallurgy art and the limitations of the then readily available low/medium carbon industrial steels. What is key here, is that the M98 action was engineered with the above metallurgy and almost every other imaginable field use and manufacturing problem in mind. Mauser designed and produced a case hardened action that was tough, but not brittle, so that it would not shatter when stressed or when high pressure gasses were suddenly released. No bolt action mechanism or later spinoff of the M98 design has ever handled gas venting better. The M98 action was further designed to vent gasses away from the shooter's face. Mauser did not rely on metallurgy to provide a safety factor: instead, he engineered it in.

Parts made from low/medium carbon steels, unless altered by over carburizing, are almost impossible to harden to a brittle state. For this reason, Mauser M98 bolts and receivers can be reheat treated even 90 years, or more, after original manufacture with little risk of embrittlement. If receiver case depth of .010" to .015" is a given, and representative exterior testing indicates a receiver hardness of RC35 to RC40, further tests to determine skin hardness on other scales would be almost academic. A Mauser bolt and receiver that have been correctly inspected, prepared, mated, and reheat treated by a qualified firm, as discussed on earlier pages, can be considered functionally as new.

Although there have been a few genuine improvements on the M98 design over the years that were not made by Mauser, such as relocating the ejector to eliminate the need for the extractor cut in the top bolt lug to make the lug stronger, most of the changes in spinoffs made by other manufacturers have been made to eliminate manufacturing steps, simplify production, and lower costs.

Mauser rifles, and rifles with Mauser actions, have been produced around the world for more than one hundred years. Few products can withstand that test of time.